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No. 7



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AGROTECHNOLOGY

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# THE PROBLEM OF HYPOKINESIA IN COMMERCIAL ANIMAL FARMING AND METHODS OF PREVENTION THEREOF

Moscow ZHIVOTNOVODSTVO in Russian No 5, 1977 pp 64-65

[Article by Prof A. K. Danilova and I. S. Shpits, Candidate of Biological Sciences, Moscow Veterinary Academy]

[Text] The main distinction of the modern animal industry is that animals are considerably concentrated in a limited area. For example, wide use is made of cages to maintain all age groups of chickens, raise chicks, ducklings and broiler ducks, other animals, as well as sows with piglets and young pigs for fattening; calves are raised on tethers and cattle is not put out to pasture. These technological procedures increase significantly the productivity of labor of service personnel, they increase the yield per unit area and facilitate regulation of microclimate in barns as well as observation of the animals' condition.

Thus, as compared to fattening pigs on the floor (20 head per stall), keeping them in three-level cages (2 per cage) increases the capacity of the barn by 2.5-3 times, reduces the cost per head-space by 50%, lowers the outlay of feed per unit increment by 25-30%, while increment [weight gain] increases by 20-25%. This is associated with 4-5-fold decrease in labor, which permits a significant increase in work load per pig-hand (A. T. D'yakonov, 1974).

Analogous data have been obtained with regard to keeping commercial and breeding hens in cages.

The new technological procedures limit motor activity of the animals, and thereby diminish expenditure of energy for movement.

However, along with its beneficial aspects, there are also undesirable ones in modern technology of animal maintenance. The effect on the physiological condition is often manifested by diminished viability, productivity, reproductive capacity and deterioration of product quality. Hypokinesia alters markedly the entire physiological status of an animal.

Thus, a study of qualitative and quantitative indices of Tagil'skiy breed bull sperm and fertility of cows revealed that when breeding bulls are deprived of active mobility this has an adverse effect on all of the indices studied (V. P. Poroshin, V. I. Oboskalov, 1974).

In a study of the effects of maitenance methods on reproductive functions of cows, V. Sterk et al. (1974) established that when they are kept indoors on tethers, they deliver fewer live calves, there are more cases of retention of the placenta and endometritis, as compared to dairy cows that are unrestricted. Limited motor activity of young bulls, when intensively raised in stalls, induced mineral deficiency in the bones of the young animals and a sharp decrease in hydroxyproline levels, as compared to bullocks raised in both stalls and allowed to graze, in spite of profuse feeding and green mass supplement. In bullocks raised in stalls, the tensile strength of the metacarpal bones was 1790 kg, whereas with stall and pasture maintenance it was 2070 kg (B. S. Sivchik, I. V. Ruvald, 1974).

Rather substantial changes in physiological status, behavior and qualitative indices of productivity occurred in commercial and breeder flocks of chickens kept in cages.

In this case, profound disturbances occur in behavioral reactions of layers: they remain in one corner of the cage and display aggressiveness, which is manifested by outbreaks of cannibalism. All these factors worsen the hens' condition.

There are profound disturbances of mineral metabolism when hens and roosters are kept in cages. Hens present impaired formation of egg shell and a large number of defects therein (up to 20% of gross yield), skeletal demineralization in the form of "cell fatigue" syndrome, which is particularly typical in highly productive hens. In roosters, hypodynamia is associated with skeletal demineralization, as well as diminished reproductivity.

For this reason, it is of both theoretical and great practical importance to investigate metabolism in animals in a state of hypokinesia, in order to develop optimum life-support and feeding conditions, which would normalize their physiological condition.

Model experiments on laboratory animals (in particular, albino rats) permit investigation of physiological changes in the animal organism when their mobility is restricted. As shown by model studies, albino rats kept under hypokinetic conditions (small cages) presented retarded development, as compared to control animals.

Changes in a number of indices were noted in a study of metabolism in hypokinetic animals. Thus, prolonged restriction of muscular activity led to a change in calcium metabolism. It was established that there is elevation of calcium level in plasma and greater excretion thereof in urine and feces. Concurrently, there was increased excretion of phosphorus in urine. Changes were observed in nitrogen metabolism: negative nitrogen balance, 50-100%

increase in nitrogen content of urine, while creatine level rose by over 4 times. Hypokinesia was associated with increased breakdown of glycogen in the liver, which lowered its content by a mean of 89%.

Thus, it can be assumed that the proportion of nutrients in the diet of animals maintained under hypokinetic conditions should be different from diets intended for animals whose mobility is not restricted. In this case, the diet, as one of the important factors affecting metabolism, could normalize the latter and increase the organism's resistance to deleterious environmental effects.

Diets that contain a large amount of carbohydrates, as well as a somewhat higher fat content, may be considered the most suitable for hypokinetic conditions.

The results of model studies were confirmed in experiments on animals and fowl that were commercially raised under hypokinetic conditions.

Feeding Kholmogorskiy cows sugar beets, at the rate of 5-10 kg per head, per day, increased milk yield from 3835 to 4547 kg, and its fat content from 3.55 to 3.68%. Calves given sugar beets as part of their diets showed the highest weight gain; furthermore, they had fewer diseases of the gastro-intestinal tract. Addition of sugar beets to the diet of broiler chickens kept in cages increased blood sugar content, as well as increased glycogen and protein content of the liver.

Experiments were conducted on chickens, kept in cages, involving addition of sugar (8 g per head) as a source of assimilable carbohydrates. The obtained results confirmed its beneficial effect on alleviating hypodynamic conditions: egg yield increased by 3.7% and egg mass increased by 5.3%, with concurrent increase in hardness of egg shells.

The studies revealed that addition of fat(4.0%) to the diet of layers kept in cages normalizes metabolic processes, increases egg productivity and quality.

Thus, the model experiments on laboratory animals and experiments with livestock and fowl under commercial conditions established that hypodynamia elicits changes in metabolism that can be successfully prevented by adding increased amounts of readily assimilated carbohydrates and fats to the diets.

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AGROTECHNOLOGY

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# ORGANIZATION OF TRANSPORTATION OPERATIONS IN ANIMAL-RAISING COMPLEXES

Moscow ZHIVOTNOVODSTVO in Russian No 5, 1977 pp 76-78

[Article by V. I. Kotelyanets, Candidate of Economic Sciences, Ukrainian Scientific Research Institute of Economics and Organization of Agriculture]

[Text] A review of operation of major specialized farms and animal-raising complexes in Ukrainian SSR shows that, with increase in animal density, there is better organization of production and a higher level of mechanization of production processes. At large farms and complexes, there is more rational use of production resources; productivity of labor is considerably higher and productions costs are lower. At the same time, travel distances are greater and the overall freight turnover is increasing with concentration of livestock.

We shall discuss changes in some indices, that are occurring under these conditions. Studies conducted in Kievskaya, Cherkasskaya and Korovogradskaya oblasts served as the basis for our estimates; there, dairy farms have 40 cows and 125 head being fattened per 100 ha farm land. With 2.5-fold increase in number of animals (from 800 to 2000 head), the mean distance over which cows are transported to and from the complex per day is increasing by 1.6 times, and freight turnover, by 3.9 times. In complexes where young cattle are raised and fattened, an increase in stock from 3,000 to 15,000 head increases the mean distance of freight hauling by 2.2 times, and freight turnover by 11 times.

At large farms, freight turnover referable only to feed and manure now constitutes a mean of 1.5-2 million t/km. Moreover, there is almost the same volume of transportation operations (transportation of building and repair materials, coal, fuel and lubricants, mineral fertilizers, seeds, etc.) for the normal operation of these farms. Under these conditions, the role of transportation is increasing, and the problem of rational and most efficient use of transportation resources in large farms and complexes is becoming more acute.

In this regard, an important question is being debated among production and scientific workers: where should the transportation that services animal-raising complexes be located? Some believe that, since the level of

use of motor transport in kolkhozes, sovkhozes and complexes is low, it should be concentrated at large motor transport enterprises. Of course, this is the general trend. However, one must take into consideration the specifics of agricultural production and, first of all, its decentralization over large territories, the need for daily (in the animal industry) use, or for most of the year (plant growing), of motor transport in technological processes. On this basis, the availability of their own motor transport resources in animal-raising complexes* is one of the important prerequisites for normal production.

At the same time, the uneven need for transportation in the course of the year makes it undesirable to concentrate all of the motor transport resources in the farms. They require two forms of transport services: their own transport resources and those drawn upon from elsewhere during the period of mass-scale freight transportation.

Thus, along with development of large specialized motor transport enterprises (interfarm, special motor bases to service suburban sovkhozes, etc.), the motor transport establishment of large kolkhozes, sovkhozes and complexes must be upgraded, supplying them with new vehicles and altering the structure of the rolling stock.

The chief forms of transport at complexes are motor vehicles and tractors, so that it is an important task to improve the efficiency of their operation. There is a tendency toward increasing the distance of mean daily runs and lowering the coefficients of run use, as well as decrease in number of days of vehicle operation per year. As a result, the productivity of some vehicles remains relatively low in some complexes (Table).

For the sake of comparison, we considered four complexes: three where swine are fattened and one, the sovkhoz-combine imeni 25th Congress of CPSU, where cattle is fattened. Best use of motor transport is made at the Apostolovskiy sovkhoz-combine, where every vehicle worked 50 days more , the mean daily runs were 58 km longer, and coefficient of run use was 18.2% higher in 1975 than at the Grakovskiy sovkhoz-combine. Consequently, at Apostolovskiy, the productivity of vehicles was 2 times higher in tons and 2.5 times higher in ton-kilometers, as compared to Grakovskiy. As a rule, with increase in productivity of vehicles, there is a decrease in cost of transportation. The cost is 11.9 kopeks lower per 10 t/km, or 15.5% lower, at the Apostolovskiy sovkhoz-combine than at Grakovskiy.

The sovkhoz-combines imeni 25th CPSU Congress and Uglegorskiy occupy an intermediate place, according to utilization of motor transport; their indices are about the same as in most other farms. By using their reserves capably, these farms could improve the operation of motor transport and

*Here and elsewhere, we refer to complexes that have the acreage and produce their own feed, i.e., so-called sovkhoz-combines.

achieve the same operational and economic indices as at the Apostolovskiy sovkhoz-combine.

Indices of utilization of motor transport at sovkhoz-combines in 1975

| Index | Sovkhoz-combines | | | |
|---|---|---|---|---|
| | Apostolovskiy, Dnepropetrovskaya Oblast | Petrovskiy, Kiev Oblast | Uglegorskiy, Donetskaya Oblast | Grakovskiy, Khar'kovskaya Oblast |
| Work/vehicle (days) | 285 | 226 | 244 | 235 |
| Mean daily run (km) | 197 | 187 | 171 | 139 |
| Coefficient of run use | 0.53 | 0.46 | 0.57 | 0.46 |
| Vehicle productivity per ton capacity* | 1045 / 34.0 | 649 / 18.3 | 573 / 17.9 | 521 / 13.3 |
| Cost per 10 t/km (kopeks) | 64.7 | 73.0 | 82.0 | 76.6 |

*Numerator--tons, denominator--thousands of t/km

In order to increase the economic effectiveness of operation of motor transport in large animal-raising farms and to lower the cost of freight hauling, a set of measures must be implemented to upgrade organization of transportation work.

One of the main causes of poor use of vehicles is their unsatisfactory condition, as well as considerable idle periods during repairs and maintenance. Of the total number of days when the vehicles were not in service, 70-80% was referable to technical reasons. As a result, motor transport is not in service for more than 220-240 days per year at some farms. Under such conditions, it is becoming important to upgrade organization of repair and maintenance of vehicles, which are performed, in most cases, in kolkhoz and sovkhoz shops.

In order to increase the mean daily runs, more attention must be given to road maintenance (including roads in the field). In progressive farms, there is a permanent team of highway workers, equipped with graders, rollers, etc. This increases the technical speed of the vehicles. Measures should also be implemented to complete mechanization of loading and unloading. In spite of the fact that all loading and unloading is mechanized at the complexes (farms) proper, when hauling vegetables, fruit, building material and certain other types of freight, the trucks idle for a long time for loading and unloading operations. And this affects the overall indices of motor transport use at the farm.

In spite of the fact that up to 100-150 vehicles, including specialized motor transport, are used in the complexes, organization and management have remained, in most cases, on the same level as in kolkhozes and sovkhozes with 15-20 vehicles. Consequently, first of all, one must organize the production and organizational structure of the motor-vehicle pool.

Of course, there are no ready solutions here, since there are complexes that do not have farm land, and there are sovkhoz-combines with 10,000-15,000 ha of such land. The technological and organizational differences between complexes, as well as distinctions of freight flow in different times of the year do not enable us to furnish any unequivocal solution. At the same time, there should be the same main goal: prompt transport servicing of the complex and other subdivisions of a farm.

A review of utilization of motor transport in complexes enables us to conclude that the team system should be the main form of organization. A good team system has been set up in organizing motor transport operation, for example at the cattle-fattening complex of the sovkhoz-combine imeni 25th CPSU. There, they have 10,000 head of cattle at a time. All of the farming is done for the production of feed. In the summer, using only the SB-1.5 vehicles, about 100,000 t green mass for the production of pellets must be hauled a mean distance of 12-15 km. Moreover, large amounts of organic and mineral fertilizers, etc., are transported to the fields. Most of the work is done by motor transport consisting of 128 trucks and special vehicles. The entire motor transport resources are distributed in teams, each of which has 8-12 motor vehicles. All of the dump trucks are concentrated in three teams and "bortovyye" trucks, in four; there is a team of feed-distributing trucks and cattle-carrying trucks. All of the narrowly specialized motor transport (irrigators, refueling trucks, etc.) are concentrated in two teams.

A review of the operation of motor transport in the sovkhoz-combine imeni 25th CPSU Congress and other farms leads us to conclude that the team method of organizing the work of drivers is the most promising. There is better use of the motor pool; one can distinctly determine the contribution of each team member to the work and his attitude toward it, increase the work and production discipline, as well as adopt progressive forms of organization of freight hauling. The most experienced driver, whose authority is respected by the others, is assigned as team leader. He is given an extra 10% of the regular wages for superivisng the team.

In this farm, the motor pool management services are continuing to be upgraded: all of the teams are combined in two columns headed by supervisors. Analysis of communications on each level, each element of management, shows that the duties of column supervisors coincide, in many respects, with the duties of the head of the garage and senior mechanic. But planning of hauls and controller work [dispatching] are not done well enough, either in the entire motor pool of the complex of the sovkhoz-combine imeni 25th CPSU Congress, or the separate columns. For this reason, establishment of columns is expedient only if the rolling stock is decentralized. If all of the vehicles are on the same lot and they number 80-120, one should not organize columns.

The operational service can be strengthened if the column supervisors are relieved, and this is important. In agriculture, the operational service not only implements trucking for the plant-growing and animal-raising branches of farms, but should pursue work to eradicate repeated hauls that are not

rational and unjustified by the technological requirements, redistribution of freight among motor and tractor transport, among motor transport of complexes and that drawn from other organizations during periods of mass-scale freight hauling.

There are many tractors with trailers in use in the complexes, along with motor transport. In the summer, the cost per ton of feed removed from the field over a distance of 4-5 km by motor vehicles constitutes a mean of 40-50 kopeks, whereas the cost is 60-80 kopeks with the use of MTZ-50 and YuMZ-6L tractors with 2PTS-4 trailers. In view of the fact that a large amount of feed is delivered to farms and complexes even during periods when the roads are impassable, it is not expedient to operate motor vehicles for such work.

Studies have shown that if we were to proceed from the need to haul freight under different road conditions, as well as optimum combination of available transport resources at farms and implementation of prompt performance of all hauling work at complexes and farms, it is purposeful to use tractors with trailers for hauls over distances of up to 4-5 km. Motor vehicles can be used the most efficiently for distances of 3 km or more. The range of use of motor transport should increase with increase in load capacity of the vehicles.

Proper unitizing is very important for effective use of tractors in hauling work. For complexes, the T-150K tractors with 1PTS-9 and 3PTS-12 trailers are the most effective. However, MTZ-50, YuMZ-6L and other tractors, with 4 t trailers are often used. And, as shown by special investigations at several scientific research institutes, the load on tractor engines does not exceed 50%. For this reason, it would be expedient to unitize tractor trains with two trailers for hauling green and rough fodder, manure and other loads. This has been done in many oblasts, and the practice merits broad adoption. Unquestionably, one should run tractor trains where the topography and road conditions permit. Unitization of tractors with two trailers will increase the productivity of tractor operator labor referable to hauling work by almost 100%, and will make a significant number of tractors available for other work.

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# ALL-RUSSIAN SEMINAR ON ORGANIZING PRODUCTION OF MIXED FEED, FEED SUPPLEMENTS AT INTERFARM ENTERPRISES

Moscow ZHIVOTNOVODSTVO in Russian No 5, 1977 pp 83-86

[Article by G. Osipov]

[Text] The RSFSR Ministry of Agriculture organized a seminar on the subject of "Organization of Production of Mixed Feed and Feed Supplements at Interfarm Enterprises," for the purpose of broad dissemination of the progressive knowhow acquired by kolkhozes and sovkhozes of this republic in the production of mixed feed and construction of mixed feed plants on an interfarm basis; it convened in Pense on 17 and 18 March 1977. There were more than 200 participants in the seminar, including deputy ministers of agriculture of autonomous republics, deputy directors of kray and oblast administrations of agriculture, supervisors of interkolkhoz and interfarm associations for the production of mixed feed and feed supplements, administrators of interfarm mixed feed plants, representatives of Party and agricultural organizations, scientists and specialists in agriculture and procurement, etc.

A. A. Glushenkov, deputy chairman of the Penzenskaya Oblast executive committee opened the seminar with a welcoming speech to the seminar participants. G. S. Ogryzkin, RSFSR deputy minister of agriculture, delivered a paper entitled "Status and Future Development of Interfarm Enterprises for the Production of Feed and Feed Additives."

In his paper, G. S. Ogryzkin observed that the changeover of animal-industry products to a commercial basis and continued increase in amount of cattle at kolkhozes and sovkhozes impose increased requirements, with regard to feeding livestock and fowl.

In 1976, the farms of the Russian Federation processed rough and succulent fodder constituting 23.2 million t feed units more than in 1975, and 12.9 million t more than in 1974. In the last few years, broad use is being made in the republic of progressive technology of feed processing, directed toward reducing loss of nutrients and improving their quality. Many farms use progressive methods of processing feed: active ventilation and compression of hay, storing silage with carbamide and preservatives, preforming granules

and pellets. In 1976, 3.4 million t hay was compressed and over 1 million t was stored by the method of active ventilation; 33.5 million t hay was stored, which constitutes 2 t per cow; 3.2 million t, or 857,000 t more than in 1975, of grass meal was produced.

However, G. S. Ogryzkin observed that, in spite of the increased production of feed, the general status of the feed base cannot be deemed satisfactory. Storing an adequate amount of feed is only one aspect of the problem. Another aspect consists of having high feed quality. Thus, in 1976, due to infractions in technology of processing and storing, delay in harvesting work, almost half the processed hay, "senazh" [baled hay?] and silage was of poor quality. In this regard, further extension of organization of specialized farms and associations for the production of feed on the basis of interfarm cooperation and agrocommercial integration merits implementation. For example, the Peremushl'skiy "Korma" production association in Kaluzhskaya Oblast increased the productivity of marshland hay meadows and pastures by almost 100% in the years since it was organized (since 1972).

Organization of such associations has been developed the most in Tul'skaya, Bryanskaya, Vladimirskaya, Rostovskaya and other oblasts in the republic. In his paper, G. S. Ogryzkin devoted much attention to development of state mixed feed industry and building of kolkhoz, sovkhoz and interfarm mixed feed enterprises. The June (1970) plenum of the Central Committee CPSU initiated development of the mixed feed industry in kolkhozes and sovkhozes. In its decree, there are plans to implement comprehensive development of the mixed feed industry, to rebuild existing state mixed feed plants and build new ones, to produce economical, automated mixed feed units on a mass scale for kolkhozes and sovkhozes, and to achieve a significant increase in grass meal.

As of the start of 1977, there were 2030 mixed feed enterprises (with a productivity of 54.9 t mixed feed per shift), including 350 interfarm plants (11600 t per shift), in the system of the RSFSR Ministry of Agriculture.

In the years of the 9th Five-Year Plan, the overall capital investment made for development of the mixed feed industry in kolkhozes and sovkhozes of the republic constituted 600 million rubles.

G. S. Ogryzkin remarked that much work has been done, with regard to use [or acquisition] of capital investments in Voronezhskaya, Kuybyshevskaya, Pensenskaya, Rostovskaya, Kurganskaya, Belgorodskaya and Orenburgskaya oblasts, Mordovian and Chuvash autonomous republics, the mixed feed enterprises of which have a production capability that will enable them to process into mixed feed all of the fodder grain allocated for this purpose.

The 10th Five-Year Plan proposes to allocate 554 million rubles for the construction of 1679 mixed feed enterprises, 456 of which will be interfarm plants, which will permit production of 24 million t mixed feed and feed mixtures by the end of the Five-Year Plan. The speaker then mentioned that one should build interfar mixed feed plants in the center of share-holding

farms and, if possible, close to railroads and paved roads, to avoid excessive transportation expenses to deliver the products to the farms.

It is planned to build interfarm mixed feed plants on the basis of servicing the farms of one or several administrative rayons. The example of Stavropol'skiy Kray merits attention; there, measures have been worked out to augment the production of mixed feed and feed supplements in 1977-1980, which provide for the construction of 11 interfarm mixed feed plants to produce 800,000 t feed and organization of 13 special establishments to produce 94,000 t grass meal.

Measures have been worked out for the development of production of mixed feed in the 10th Five-Year Plan in Krasnodarskiy Kray, Penzenskaya Oblast, Mari ASSR, etc. In this paper, the agricultural agencies of Novgorodskaya, Pskovskaya, Vladimirskaya, Tul'skaya, Volgogradskaya, Chelyabinskaya and Irkutskaya Oblast and Bashkir ASSR were critized: only 2-10% of the plan for mixed feed production was fulfilled there, whereas production of mixed feed was not even started in Ivanovskaya, Kaluzhskaya, Tambovskaya, Orlovskaya, Kemerovskaya and Chitinskaya oblast farms.

Some good results were obtained by many enterprises in the production of mixed feed in 1976. For example, the Otradnenskiy interkolkhoz mixed feed plant in Krasnodarskiy Kray, which involved 12 kolkhoz shareholders, produced over 25,000 t mixed feed in 1976; at the Predgornyy interfarm mixed feed plant in Stavropol'skiy Kray, over 24,000 t mixed feed was produced, with 1700 t for each shareholder.

Along with the good results, it was observed that many interfarm mixed feed plants do not make full use of their production capability; not enough attention is given to questions of sufficient supply of raw material, equipment and technology in the plants; the situation is poor with regard to supply of qualified personnel.

Much attention was devoted in this paper to the production of high-quality raw material for the production of mixed feed. For this purpose, G. S. Ogryzkin observed, it is imperative to make more rational use of the land, on which there must be sufficient cultivation of leguminous crops (peas, etc.), as well as barley, oats and corn; it is imperative to produce annual and perennial grasses on irrigated land, as raw material for grass meal.

It is planned to further specialize kolkhozes and sovkhozes in the next few years; they must produce 5,000-10,000 t grass meal annually, using the SB-1.5 units and OGM-1.5 granulators.

To make up for the shortage of protein in the diet of ruminant animals, it is important to use carbamide concentrate. According to the speaker, a method of obtaining carbamide concentrate by the extrusion method was adopted in 1975.

As of 1 January 1977, there were 1953 extruders in the republic's oblasts, and they were used to produce over 46,000 t carbomide concentrate.

Much knowhow has been gained in the production and use of carbamide concentrate, according to the speaker, in Mari ASSR, Rostovskaya, Ryazanskaya, Penzenskaya oblasts, Krasnodarskiy Kray, etc.

In order to investigate the efficacy of carbamide concentrate as a feed supplement for ruminant animals, a VNIIFBIP [? but could be typo for All-Union Scientific Research Institute of Physiology and Biochemistry of Farm Animals] base was organized in the republic.

In this republic, there are 13 plants that produced 5,700 t meat and bone meal and 1,300 t "technical" fat in 1976. Under the current Five-Year Plan, 53 such plants will be built; by 1980, the production of feed yeast will increase to 57,000 t; the production of dry skim milk in interfarm enterprises will reach 23,000 t by the end of this 5-year period. The RSFSR Ministry of Agriculture, along with the All-Union Scientific Research Institute of the Mixed Feed Industry (VNIIKP) developed the following to render practical assistance locally: "Recommendations for the Production of Mixed Feed and Feed Mixtures at Kolkhoz, Sovkhoz and Interfarm Mixed Feed Enterprises," "Temporary Recommendations on Organization of Production and Use of Carbamide Concentrate in the Diet of Ruminants," "Technical Specifications for Carbamide Concentrate" and "Recommendations for Adding Fats to Feed." These recommendations can be used locally as educational aids for practical guidance.

G. S. Ogryzkin then stressed the need to organize self-supporting associations in oblasts, krays and autonomous republics for the purpose of centralized management of interfarm mixed feed enterprises. Associations for the production of mixed feed and feed supplements have been set up at the administrations for agriculture in Penzenskaya and Kuybyshevskaya oblasts, Krasnodarskiy Kray and Chuvash ASSR; departments for the production of mixed feed have been set up at the Kolkhozzhivprom [Kolkhoz Animal Industry] associations in Mari ASSR, Stavropol'skiy Kray, Belgorodskaya, Voronezhskaya, Chelyabinskaya and Kurganskaya oblasts.

G. S. Ogryzkin observed that there is enough knowhow in the RSFSR to achieve a radical breakthrough in the years of the current Five-Year Plan in development of production of mixed feed and feed supplements at interfarm enterprises, kolkozes and sovkhozes in the republic. He expressed his confidence that the administrators of agricultural agencies, kolkhozes and sovkhozes, and mixed feed enterprises will take every step to succeed in fulfilling the tasks set forth by the 25th CPSU Congress for continued development of agriculture in the nation.

L. T. Zarva, chairman of the specialized association for the production of mixed feed and feed supplements in Penzenskaya Oblast, delivered a paper on the work of this association. He reported that one of the objectives of the association, which was created in 1975, is to implement qualified guidance for the operation of mixed feed enterprises.

A. T. Zarva reported that construction of interfarm mixed feed plants in his oblast began in 1973. At the present time, there are 8 such plants under construction, which will have a capacity of 50-75 t mixed feed per shift. Eight plants have already been built and are functional. With the operation of 2 shifts, the 8 existing plants could produce 1000-1100 t mixed feed per day. More than 12 million rubles of kolkhoz and sovkhoz funds have been allocated for the construction of interfarm mixed feed plants. At the present time, the interfarm mixed feed plants deliver feed to 230 kolkhozes and sovkhozes (of the 409 farms in the oblast).

There is a shop that produces carbamide concentrate, producing 10,000 t per year, at the Penzenskiy interfarm mixed feed plant to supply this form of feed to the animal industry. In addition, 4 more such shops will be built at this plant in 1977.

By the end of 1980, it is planned to bring production of carbamide concentrate up to 152,000 t per year, which will fully meet the animal industry needs of this supplement.

L. T. Zarva then observed that, with regard to organizations of material and technical supply, problems of supplying mixed feed plants with spare parts, equipment for laboratories, reagents, transport, protein-vitamin supplements are not being resolved. Questions of training personnel, organizing a repair base, etc., are not being well-handled; recommendations are needed concerning regular staffs for mixed feed plants, associations and warehouses. Planning organizations have not yet worked out the plans for technological lines to produce mixed feed for young animals.

Yu. D. Zakharov, deputy manager of the Kurgankolkhozzhivprom Association, delivered a paper on the subject of "Experience in Organizing Construction and Operation of Interfarm Mixed Feed Enterprises Using OKTs [expansion unknown] equipment in Kurganskaya Oblast." He reported that, at the present time, there are nine interfarm mixed feed plants, five of which have OKTs-50 units. By the end of 1977, there will be a total of 13 plants, including 9 with OKTs-50 units. While 5,100 t feed was produced in 1973 (when development of the mixed feed industry began), in 1976 80,000 t were produced, or 16 times more.

Yu. D. Zakharov observed that some serious flaws were detected in the course of construction and operation of mixed feed plants using OKTs-50 units in accordance with plan 269-71. Thus, 10-ton scales had to be replaced with 30-ton scales at all of the plants in operation, for more convenient weighing of heavy trucks. There should also be an increase in grain storage space, i.e., to accommodate up to 12,000-15,000 t instead of 3,600 t. Furthermore, according to plan 269-71, dispensing mixed feed takes 20-25 min. For this reason, in several plants of the OKTs-50 type, separate storage hoppers have been installed, apart from the weighing room, which reduced the truck-loading time by 4-5 times. Other improvements have also been made in the plan.

The speaker then indicated that supplying interfarm mixed feed plants with spare parts and units (for example, KDM crusher snail-case housings and

decks, TSTs carrier chains, reduction gears for bucket chains, worm feeders [screw conveyers], carriers, etc.) is a problem area in the Sel'khoztekhnika enterprises.

Aid is also needed from the RSFSR Ministry of Agriculture, with regard to prompt, centralized supply of raw material and protein and vitamin supplements to assure rhythmic operation of mixed feed plants. Furthermore, the plants need their own special transport (for example, 3SK-10 vehicles) to haul grain and mixed feed. V. V. Bykov, chairman of the Krasnodar Association for Mixed Feed Production, delivered a paper on organization, technology and economics of mixed feed production at interfarm mixed feed enterprises. He reported that a kray interkolkhoz production association for the production of mixed feed and feed supplements--Kraykolkhozkombikorm--was created in October 1976. The association is comprised of 10 operating interkolkhoz mixed feed plants producing 450,000 t mixed feed per year, the Maykop combine for the production of protein supplements that produces 3,000 t feed yeast and 11,000 t protein-vitamin supplements per year, and 4 mixed feed plants under construction. By the end of the current 5-year period, the association will consist of 50 enterprises in the mixed feed industry, which will produce 1.5 million t mixed feed, 1.5 million t complete diet granules [pellets], 38,000 t yeast, 11,000 t protein and vitamin supplements and other products. In 1976, the interkolkhoz mixed feed plants produced 165,700 t mixed feed. The average cost per ton mixed feed to the association constituted 72.65 rubles.

The relationship between the plants and shareholding farms is based on contractual agreements. The contract stipulates date of delivery of raw material to the plant by the shareholders and delivery by the plant of products to the farms. In addition, coefficients are determined for delivery of mixed feed. The contractual relationship aids in growth of production and quality of produced goods, with lowering of their cost. For example, in Otradnenskiy Rayon, much work was done to implement cooperative production of mixed feed at interkolkhoz plants. In this rayon, the mixed feed produced at these plants is 25-30% cheaper than at state plants. V. V. Bykov further observed that development of mixed feed production on an interkolkhoz basis is being delayed by the lack of centralized material and technical supply and specialized transport at the plants. Rossel'khoztekhnika can still not properly organize material and technical supply, for which reason the plants remain idle for up to 15% of the work time due to a shortage of needed equipment, spare parts and materials, which delays prompt refinement of the technological process.

The speaker addressed a request to the RSFSR Ministry of Procurement with regard to implementing prompt delivery of protein and vitamin supplements for the different species of animals and fowl to interkolkhoz mixed feed plants.

In concluding his paper, V. V. Bykov stated that blue and white collar workers, and the engineering-technical personnel of the interkolkhoz mixed

feed industry of Krasnodarskiy Kray, in celebrating the 60th anniversary of Great October, took on greater social obligations: to implement production of 280,000 t mixed feed and 8,000 t carbamide concentrate. This is 1.8 times more than the mixed feed production in 1976.

Yu. G. Bogomolov, head of a laboratory at the Donskoy Zonal Scientific Research Institute of Agriculture delivered a paper on organization of production and use of carbamide concentrate in kolkhozes and sovkhozes of Rostovskaya Oblast.

Yu. G. Bogomolov reported that interfarm shops began to be constructed in Rostovskaya Oblast in 1975 for the production of carbamide concentrate. At the present time such shops are operating in 22 rayons of this oblast. As of 1 January 1977, 108 E-01 and KM3-2 extruders had been installed in these shops. In 1976, 9,500 t carbamide concentrate was produced, the plan calling for 6,000 t. The scientists of the Donskoy Zonal Scientific Research Institute of Agriculture have conducted experiments on the use of carbamide concentrate in the diets of cattle and sheep. As a result, it was established that such a concentrate can compensate for up to 35% of the protein lacking in the diet. The following amounts of concentrate are recommended for daily use: 600-1000 g for cows, 300-500 g for young gattle over 6 months old being fattened, 60-100 g for adult sheep and 40-60 g for lamb over 3 months old.

Carbamide concentrate has begun to be used at the Proletarskaya range for fattening 20,000 cattle, where a line of 5 extruders has been installed; instead of oil cakes [or grist], the cattles are given 5 t carbamide concentrate daily, with the mixed feed. In the second half of 1976, 17,300 head of cattle were delivered from this spread to the state, and 99% of them were of superior quality. The mean live wieght of cattle from this spread constituted 418 kg.



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CLINICAL MEDICINE

# EPIDEMIOLOGY OF HYPERTENSIVE DISEASE AMONG THE MALE POPULATION

Alma-Ata ZDRAVOOKHRANENIYE KAZAKHSTANA in Russian No 4, 1977 pp 6-7

[Article by R.A. Satpayeva, professor, head of department of hospital therapy, D.S. Polimbetov, assistant, R.I. Arykova, docent of department of Alma-Ata Medical Institute]

[Text] Hypertensive disease has been in recent years one of the most severe and widespread ailments of the cardiovascular system in all industrially developed countries. The growth of cardiovascular diseases (cardiac ischemia, hypertensive disease) is explained, one must assume, by urbanization of life, speeding up of its tempo, automation and mechanization of production processes, the growth of mental and emotional loads with simultaneous diminution of the physical activity of contemporary man. Moreover, a certain role is also played by the change in the age structure of the population, the growth of the contingent of the elderly and the old, who are the most susceptible to diseases of the cardiovascular system.

The present work presents the results of a selective survey of the male population (20-59 years of age) living in the Oktyabr'skiy Rayon of Alma-Ata. A total of 2,003 men were studied, which is 79.6 percent of the planned number of persons. Their contingent is representative of the entire population, making it possible to provide adequately substantiated conclusions. Of this number, 1,434 men did physical labor, 569--mental labor. The Oktyabr'skiy Rayon is not a central rayon of the city, and the population living in it works at enterprises where physical labor is predominant.

Arterial hypertension was found in 12.23 percent of the observations; of these hypertensive disease was diagnosed in 10.13 percent, symptomatic hypertension in 1.05 percent; the number of persons with blood pressure in the "danger zone" was 1.05 percent. The frequency of hypertensive disease increases with age from 4.38 percent for 20-29 to 19.45 for 50-59 years of age. Our findings are comparable to the results of research conducted in some cities of Kazakhstan. Thus the highest frequency of arterial hypertension was found among the inhabitants of the Sovetskiy Rayon of Alma-Ata (19.6), the lowest in Pavlodar (8.9 percent). In the Oktyabr'skiy Rayon, the frequency of arterial hypertension approximated that found in Tselinograd

(12.2 and 10.4 percent). Among the oblast cities, this ailment was found most widespread in Kzyl-Orda (15.2 percent). In studying the frequency of arterial hypertension in persons 40 years of age or older, the growth in the frequency of patients in the older age group of 40-50 (29.9) compared to the younger of 20-39 years of age (8.05 percent) was found to be statistically reliable.

Evaluation of data on the effect of the character of labor activity on the frequency of hypertensive disease among the population shows that it is found more frequently in persons engaged in mental labor (11.77 percent) than in those engaged in physical labor (9.48 percent). The obvious relation of the prevalence of the disease on the degree of nervous tension, depending on the character of labor activity, was not established for the vocational groups. The imprecise data in this connection may be explained by the fact that under the conditions of the present-day industrial city, the distinction is being obliterated between mental and physical labor, and it is difficult to find an occupation not requiring significant nervous-mental tension.

Among those suffering from hypertensive disease with a hereditary burden, there has been observed a significant predisposition to the disease (18.1 percent) than among those ill without such a heredity (14.8 percent). A hereditary predisposition was found in 21.67 percent of persons sick with hypertensive disease compared to 17.29 percent in those who were well. The results obtained were conditioned by the fact that many of those who were surveyed did not definitely know if their parents had suffered from hypertensive disease.

Data have been obtained that point to an interrelation between hypertensive disease and excess bodily weight. The number of patients with alimentary obesity was three times greater (37.32 percent) than of those with normal bodily weight (10.2 percent). It has been reliably noted statistically that alimentary obesity was three times greater among those suffering from hypertensive disease than among healthy people.

A number of clinical and experimental works have established that a many-year systematic use of excessive amounts of sodium chloride leads to the development of hypertensive disease. Our findings show that the use of increased amounts of sodium chloride with food plays a significant role in the inception and development of hypertensive disease. There were four times as many patients "who liked salty things" (25 percent) than among regulars (6.88 percent); a similar pattern was established among persons with blood pressure in the "danger zone."

In the study of hypercholesteremia as a risk factor in hypertensive disease, it was found that there were three times as many patients with hypercholesteremia (36.8 percent) as in those with a normal cholesterol level (11.9 percent). Among patients hypercholesteremia was encountered twice as frequently as among well people.

Thus a study of the epidemiology of arterial hypertension was carried out for the first time among persons of the male sex of the Oktyabr'skiy Rayon of Alma-Ata. The aforesaid epidemiological research can serve as the basis for selection of a contingent of people in need of dispensary observation, which should be combined with an extended ambulatory and hospital treatment. The need for detecting persons suffering from hypertensive disease namely at the early stages of the ailment has been shown namely by the fact that it is encountered frequently among young people (20-39 years of age), while almost half of the older men (40-59 years of age) are in a threatened position --they have either marginal or high arterial pressure. Special attention should likewise be directed to the detection of persons with blood pressure in the "danger zone" and those with a predisposition to the disease. Consequently, preventive treatment should be started ten years earlier, when in the opinion of most investigators the development of hypertensive disease is most frequently observed.



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# APPROACHES TO RESEARCH ON THE PROBLEM OF 'TOXIC CHEMICALS AND FAUNA'

Moscow USPEKHI SOVREMENNOY BIOLOGII in Russian No 3, 1977 pp 459-470

[Article by P. P. Dmitriyev and V. S. Lobachev (Moscow), Moscow State University imeni M. V. Lomonosov]

[Text] The submitted data are systematized on the basis of effects of toxic chemicals on a given structural level of organization of living matter. On the one hand, there is a direct, toxic effect on the cellular, tissular and organism levels and, on the other hand, an indirect, nontoxic effect, in the form of a nonspecific response of populations and biocenoses on disruption of evolutionarily established relations. Development of research on the levels of supraorganismic systems helps in deeper detection of changes in the fauna that occur as a result of using toxic chemicals and in gaining understanding of the mechanisms of self-regulation in populations and biocenoses.

The chemical method of controlling pests developed very rapidly. While only a few inorganic substances in the group of arsenic and copper compounds, as well as some organic products of plant origin, of the rotenone and pyretrum type, were used in the 1920's-1930's, there was a breakthrough in the 1940's: DDT appeared, the first of the organochlorine compounds. With each year, the diversity of chemicals and scope of applications are increasing. For example, in the United States, only 15-18 chemicals were used to control agricultural pests in 1955, whereas about 200 agents, referable to main products alone, were used in 1958. In that country, 900 t 0.5% concentrate of zoocides-anticoagulants are produced annually, and since 1962 chemicals have been used to treat about 40 million ha of land (mainly agricultural) per year, which is 4% of the entire area of the country (Carson, 1962).

Production and use of various pesticides is ever increasing and becoming more and more diversified in other developed countries as well. Of course, more and more new features are obtained with each year in the effects of mass use of pesticides on objects of nature. Our objective did not include enumeration and comprehensive analysis of all the numerous facts involved in the

effects of toxic chemicals on fauna, particularly since this topic has been widely covered in several surveys (see Rudd, 1964; Davis, 1966; Voronova, Torina, 1967; Voronova, Pushkar', 1968; Sokolov, Strekozov, 1970; Rudnev, Kanonova, 1971; Voronova, 1973). We have made an attempt to discuss the main directions of research on the problem of "Toxic Chemicals and Fauna," and to outline the main tasks. Pesticides have broad and diverse effects; however, use thereof is not always associated with the necessary ecological and economic analysis. The consequences of such an approach are well-known. At the same time, as the developing research elucidates some questions, it poses new ones that are more and more complex. Artificial restriction of this problem, which bore some fruit at the early stages of research, could now lead practical workers to the wrong conclusions. We shall try to briefly describe the main directions and extent to which the effects of toxic chemicals on fauna have been investigated, basing ourselves on the general scheme of organization of living matter proposed by N. P. Naumov (1967, 1971). This approach will help systematize the entire diversity of effects of toxic chemicals on the animal kingdom, and on the basis of this system it will help determine the extent to which different aspects of the problem have been investigated.

We propose a scheme of the effects of toxic chemicals on different structural levels, on the basis of summarizing the data on their effects on fauna (Figure 1).

We shall discuss each of them in greater detail. A number of studies could be referred to the biospheric level. For example, it has been found that many chemicals in the group of organochlorine compounds are capable of accumulating in the environment in significant amounts. Most of these products eventually get in the soil and reservoirs, where they persist and migrate for many years. Thus, up to 126 kg/ha DDT was detected in the soil of fruit orchards after 6 years of treatment with the product (Ginsburg, Read, 1954); after a single treatment in a dosage of 4.5 kg/ha, 0.5 kg/ha of the product remained in 6 years (Woodwell, 1961). Aldrin and dieldrin remain toxic for 8 years after use in a dosage of 11.2 kg/ha (Kiigemage et al., 1958). It is believed that, after accumulation, pesticides can persist for up to 20 years in water and up to 37 years in forest soil (Ramade, 1974).

The presence of residues of pesticides in the environment after extensive use thereof presents a serious ecological problem. The distinctions of migration, detoxification and metabolism of toxic chemicals in soil depend on many factors, including their chemistry, dosage and form of product, species composition of the flora and fauna, type, moisture, temperature and physical properties of soil, composition of soil microflora, weather conditions and how the land is tilled (Sokolov, Strekozov, 1970). It is known that stable pesticides can persist in the biosphere and circulate in it for a long time, moving from one medium to another. Many of them, or their metabolites, are demonstrable in areas where they had never been used, which is due to shifting of the products with air and water, and their involvement in complex biological cycles. The distribution of a number of pesticides in different levels of the biocenosis--soil, plant and animal kingdom--as related to animal diet has been

investigated rather comprehensively. Some works, in particular, deal with comprehensive investigation of relatively new and relatively unstable products, such as sevin and carbofos [malathion insecticide] (Vornova, Denisova, 1968; Molozhanova, 1968; Odinets, Voronova, 1970; Denisova, 1973). In many instances, the effects of toxic agents extend far beyond the treated area, so that pesticide pollution of reservoirs becomes a serious problem. This leads to a reduction of fish stock. Thus, in Japan and Indonesia, it was necessary to abandon fish farming in rice fields. Contamination of reservoirs in Africa could become a real disaster, since fish is the chief source of nutrition there ("Fish and Pesticides," 1964; Winterhalter, 1974). These facts are indicative of the global scale of effects of toxic chemicals on nature.

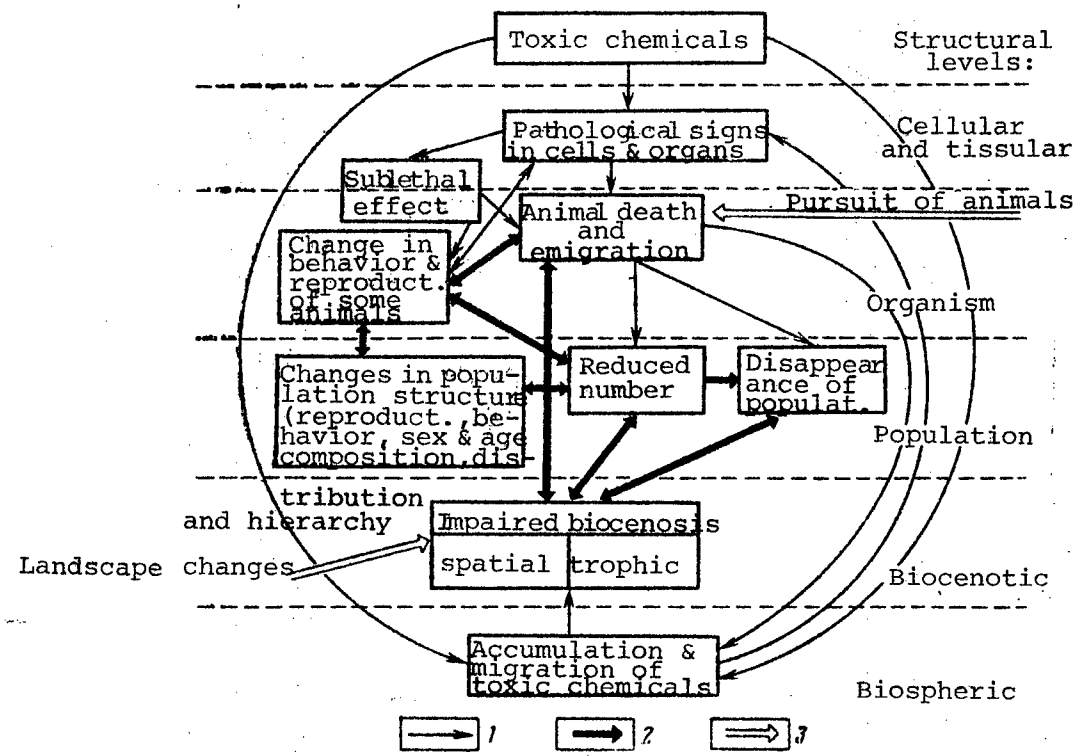


Figure 1. Diagram of effects of toxic chemicals on fauna

Effects:

1) direct, toxic and specific
2) indirect, nontoxic and nonspecific
3) possible effects of other forms of human endeavor

Accumulation and analysis of all the data resulted in the fact that several countries, including the USSR, have banned the production of some of the most stable organochlorine pesticides, increasing the production of less stable organophosphorus and carbamate insecticides.

It is only because of their breadth and enormous significance that we can arbitrarily list migration and accumulation of pesticides on the biospheric level. These phenomena are more geochemical and, in part, biocenotic in nature.

There have been overtly inadequate investigations of the effects of toxic chemicals on the cellular and tissular levels. Only the general mechanisms of action of a given poison in the organism are known, and the pathoanatomical signs of poisoning caused by many of them have been described. Physiological disturbances are possible under the influence of pesticides: higher rate of metabolism of steroids, abnormal metabolism of vitamins and enzymes (Anderson et al., 1969). Pathological changes have been noted in insect blood cells after chlorofos and polychloropinen [?] poisoning: proportion of hemocytes is impaired, many vacuoles appear in the protoplasm, the chromatin of nuclei breaks down into large granules and the nuclei become decentralized (Sekun, 1970). Determination has been made of hematological indices for evaluation of toxicity of some pesticides in fish (Popova, 1970, 1972). There are also data indicative of the genetic sequelae of pesticides. As an example, we know that 4% semilethal dosage of dieldrin and other poisons increases the incidence of chromosomal aberrations to 9.1-13% 1 hour after exposure (versus 1.6-1.8% in the control; see Markaryan, 1966), while single administration of maximum tolerable doses of carbamates of the sevin type elicits an increase in RNAase and DNAase activity in the liver and spleen (Anina, 1968).

The mutagenic and carcinogenic activity of many toxic chemicals has been proven in laboratory experiments; however, it is difficult to conceive of the extent of these phenomena in nature, since even isolated corroborative facts have not yet been recorded (Rudd, 1964; Rosival, 1969, 1970).

The numerous facts are indicative of accumulation of significant doses of stable pesticides in the animal organism (deWitt et al., 1960; Milada, 1960; Pillmore, Finley, 1963; Write, 1965; Joris et al., 1974, and others), and this could hardly fail to leave a trace. Rudd (1964) divides the sublethal effects of toxic chemicals into four categories: effects on general condition, behavior, growth and reproduction, and he indicates they have not been studied enough, stressing in particular the need for proof of such effects on field material. First of all, research is required on impairment of physiological functions, breeding of resistant forms, carcinogenic and mutagenic effects of toxic chemicals on natural populations.

The changes that occur on the cellular and tissular levels are closely interrelated with changes on the higher level of the organism. Changes in animal behavior after intake of sublethal doses of pesticides have been demonstrated in the original work of Shellhammer (unpublished data, quoted by Rudd, 1964), who studied the relationship between cholinesterase level in the brain and exploratory (mental) capacities of wild house mice. A parathion injection lowered the cholinesterase level to 25-50%. After a single injection, a previously trained mouse was submitted to retraining, and the process was much slower than the first time. Under such conditions, it was difficult to establish the sublethal effect of the poison by other methods. Evidently,

it can be stated that fine biochemical mechanisms are involved here, and they already find manifestation on the organismic level. For example, insecticides that lower the cholinesterase concentration in the brain lower the amount of enzymes in fish, and this occurs within different times (a month of more) depending on the species (Weiss, 1961).

It was also shown that under the direct influence of a toxic chemical there are changes, both in unconditioned reactions of animals to environmental factors and in their capacity to develop conditioned reflexes (Stickel, 1967; Karpenko, Avramenko, 1969; Weis, Weis, 1974). As a rule the activity and mobility of the animals diminish. Moreover, the following are observed with sublethal doses of pesticides: weight loss in most experimental animals, change in reproduction time in the direction of a 15-25-day delay, as well as decrease in number and viability of offspring and capacity for fertilization. Several insecticies and herbicides are transmitted transovarially (Feodrenko, 1967). It has been found that many toxic agents have a significant effect on oogenesis and spermatogenesis (deWitt, 1956; Linhart, Enders, 1964; Fedorenko, 1965, 1967; Shilova et al., 1968; Smirnov et al., 1970; Krylova, Denisova, 1973). The initial sublethal changes in the organism can subsequently lead to a lethal outcome.

Animals have a certain protective reaction to pesticides: occasionally, in experiments, they are capable of choosing uncontaminated feed (Fedorenko, 1967) or of avoiding bait with certain toxic chemicals (Siegfried, 1968; Elwood, 1972). N. M. Churkina (1965), who observed the behavior of different birds in an area treated with 50% DDT emulsion, divides birds into three groups: highly sensitive (all species of flycatchers, warblers [Sylviidae and Acrocephalus], tree pipits, Phylloscopus warblers), which abandoned treated areas on the 1st-2d day for 15 or more days, and often never returned; moderately sensitive (redstarts, robin redbreasts, wagtails, tits, orioles, wrynecks) that stayed away from the area for 10-15 days, then returned, and insensitive (greenfinches, buntings, thrushes [Turdidae], woodpeckers and Corvidae) which either failed to leave the treated area, or left for 2-3 days.

However, it should be noted that defense reactions are observed only under specific conditions, as the reaction of different species to some toxic chemicals, and most of the data were obtained under laboratory conditions. Deaths among invertebrates, fish, amphibians, birds and mammals are common knowledge. The data obtained from questionnaires (see Rudd, Genelly, 1956) revealed that arsenic, 2,4-D and 2,4,5-T herbicides, dieldrin, DDT, toxaphene [chlorinated camphene], tetraethylpyrophosphate, sodium monofluoracetate, strychnine, thallium sulfate and zinc phosphide have devastating effects on birds and mammals. Such estimates have been made in several countries. The Central Laboratory of Environmental Protection revealed that, in our country, animal deaths are due mainly to zinc phosphide, arsenic products, mercury disinfectants, and organochlorine compounds, DDT and hexachlorocyclohexane (Voronova et al., 1962). Use of some of these products has now been abandoned in virtually all areas.

At present, there are many facts indicative of animal deaths due to highly toxic chemicals. Let us discuss some of the data submitted in the survey of L. D. Voronova and I. G. Pushkar' (1968). After scattering poison bait containing thallium sulfate in a field, to control Muridae, many dead birds were found in the field (analysis corroborated the cause of death). Product 1080 (barium fluoroacetate) presents a great hazard; it induces secondary poisoning of predators after they consume the carcasses of poisoned rodents. For example, in some parts of the United States, use of bait with this chemical was the cause of death of coyotes. Eradication of ring doves, stock-doves, rooks, crows, jackdaws, gulls and common vole in the Netherlands resulted in mass death of birds (about 27,000 birds of 55 species in 1960, and about 200,000 in 1963).

The use of grain with zinc phosphide to control great gerbils in Priaral'skiye Karakumy resulted in the death of 15 species of rodents, 2 species of insectivores and the same number of predatory mammals, 1 species of birds and 2 of reptiles. There have also been cases of secondary poisoning of carnivores and insectivores (Naumov et al., 1972; Dmitriyev, 1974).

Poisoning of fish has been reported in several countries in the last few years. For example, in the United States, of all cases of fish deaths pesticides were responsible for 32% in 1960, 21% in 1961 and 18% in 1962. Salmonidae (sea trout, loach, whitefish [or powan]) are particularly affected when forests are treated with organochlorine insecticides (endrin, dieldrin, heptachlor, DDT) against gypsy moths and tortrix moths. Single use of DDT and hexachlorocyclohexane in salt marshes against mosquitoes led to almost total extermination of shrimp along the coast of Florida and Texas, while the use of dieldrin resulted in the death of commercial crabs (Voronova, Pushkar', 1968.

The more complex changes in fauna under the influence of pesticides, on the population level of organization of living matter, have been investigated somewhat unilaterally: in essence, they have dealt with the reduction in population size as a result of death of part of the animals (significant mortality due to poisoning occasionally leads to disappearance of some populations and even local disappearance of species). Numerous data on reduction in number of various animals following the use of toxic chemicals are submitted in the survey of L. D. Voronova and I. G. Pushkar' (1968). Let us discuss some of them as an example. After repeated use of DDT in the area around the University of Michigan, the thrush was completely eradicated. An inspection of one of the polders in the Netherlands, where DDT, dieldrin and, to a lesser extent, endosulfan, had been used for several years, revealed that there was a significant decrease in number of European hares. The use of heptachlor to control Richter ants causes severe changes in size of populations of many animal species. In areas treated in doses of 0.28-2.24 kg/ha, there was a decrease in number of song birds, and carcasses of 14 species were found. Estimates of Virginia quail revealed a severe depression in number thereof after treatment with granulated heptachlor, and the population did not recover, even after 3 years. A dead zone appeared after 2 ha forest was sprayed with heptachlor epoxide: neither birds nor mammals were found there. Use of granulated heptachlor in Alabama

was the cause of extinction of two snake species, and in Louisiana four frog species disappeared. As a result of testing phosphamide in Canada, the United States and Switzerland, there was a reduction in number of fish and aquatic invertebrates in all treated areas.

The decrease in number of animals is not only due to direct poisoning, but partial or complete arrest of reproduction when they take in sublethal doses of toxic chemicals. High concentrations of DDT and other poisons elicit thinning of birds' egg shells (Rudd, 1964; Robinson, 1970; Newton, 1974), which could lead to complete extinction of a species, as was the case with the brown pelican in California (Perlmann, 1969). In addition, failure to participate in reproduction is observed in predatory birds, and this is also attributed to the effects of pesticides (Newton, Bogan, 1974).

The main factors have been elicited (Fedorenko, 1967) that increase mortality of useful animals under the influence of toxic chemicals: repeated treatment of areas, increased dosage, use of products with high poison content, use thereof in liquid form, particularly in the summer and spring (when the animals are highly sensitive), as well as synergism, i.e., the combined effect of many toxic agents. Unfortunately, most of these factors serve as methods of enhancing efficacy of treatment.

As a rule, statements that there is a reduction in number of animals related to the use of toxic chemicals are not accompanied by a serious analysis of causes, which could be a number of population and biocenotic changes. Direct poisoning (to which any depression in number is usually attributed) is only one of the aspects of the complex changes that occur in populations as a result of this initial factor. Unfortunately, the disruption of population structure, occurring as a result of death of some animals and partial poisoning of others, has not been investigated enough as yet. There are only a few works dealing with the distinctions of animal behavior and reproduction in populations that are reduced, particularly after partial extermination (Geptner, 1956; Bibikov, Zhirnov, 1956; Dubyanskiy, 1963; Dmitriyev, 1972). It was observed that visual and auditory communication is impaired in such populations; at first activity and mobility diminish, then increase sharply, which leads to even greater (at the early stages ) reduction in number. Some increase in intensity of reproduction of the healthy part of the population favors restoration (Yakovlev, Radchenko, 1968; Dmitriyev, 1974). The rate of restoration of number of animals following exposure to chemicals depends on the residual population density, distribution of animals over the area, sex and age composition, climate and other conditions. It may be faster if there is a possibility of occupying an adjacent area, the so-called factor of biological vacuum. For example, according to Morris (1970), the number of adult migrating animals after treating an area, even with the minimally toxic product, eldrin (60% reduction in number of voles), doubles. Furthermore, in view of disruption of the structure of a group in the treated area, the new arrivals probably do not encounter much competition and settle there willingly. While only 27-41% of the new arrivals remained in the control area, this applied to 64-65% in the treated areas.

Morris (1972) devotes a special place in his recent work to changes on the population level under the influence of toxic chemicals; on the basis of a number of data (Snyder, 1963; Rudd, 1964; Barret, Darrell, 1967; Barret, 1968; Malone, 1969; Morris, 1970), he proposes a model of the effects of pesticides on populations (Figure 2). They consist of direct lethal and sublethal toxic, and indirect nontoxic effects, which can extent to adjacent areas where the products were not used. The proposed scheme has been confirmed for many vertebrates. As an example, McEwan and Brown (1966), who worked with Pedioectes phasianellus birds, showed that even one sublethal dose of dieldrin induces changes in hierarchy among males and increases the susceptibility of both sexes to attacks by predators. At the same time, this scheme cannot be universal, since the effect of a poison depends not only on its chemistry, but on the species of animal. Several of the hypotheses of Morris have not yet been proven, at any rate not for natural populations.

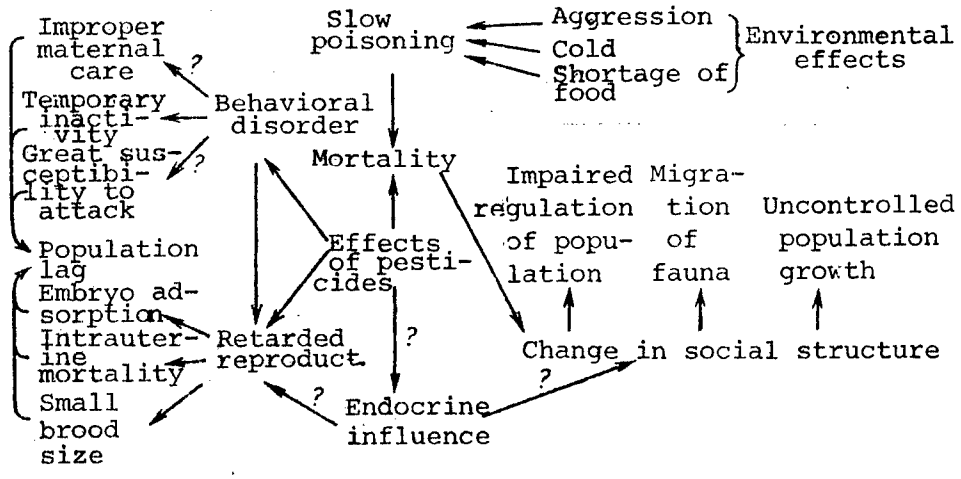


Figure 2. Routes of influence of pesticides on fauna (according to Morris, 1972). The question marks refer to effects that have not been proven in wild mammals.

On the whole, these few facts are the extent of investigation of complex population changes, which occur for several reasons: death of part of the population, stress state of the surviving animals that ingested sublethal doses, increase or decrease in pressure of predators, symbionts, parasites, diseases, as well as disruption of habitat, changes in feed base, etc. In this regard, we can anticipate a set of disturbances in the population structure of many species: specific changes in behavior, hierarchic relations, age and sex composition of populations, intensification or reduction of reproduction under the influence of opposite factors, as well as distribution of the species over the area. These disturbances must be traced in the most diverse populations, from parceled to geographic.

Indeed, in most works dealing with the effects of toxic chemicals on animals, individual deaths or mortality rate [percentage] in the population are used

as the main criteria. But a population is not simply the sum of individuals, and a decrease in its size due to the use of pesticides or other causes should elicit qualitative and quantitative changes in the entire population, the chief cause of which is competition for food, shelter and mates.

More recently, research on mammalian behavior (particularly rodents) as related to population density has gained considerable development. The general theory of Christian (1959) relates regulation of population size to endocrine changes occurring in connection with variations in behavior and correlations between animals in a group. A change in population density leads to profound disturbances in physiology and reproductive capacity of mammals (Christian, Davis, 1957). Similar phenomena have been noted in birds and insects (Wellington, 1960). The existence of these complex changes is no longer questioned by anyone, although their mechanisms have not yet been conclusively identified (Chitty, 1964). The role of population density is of decisive significance to the fate of a community, although this is not the only means of self-regulation in a population (Petrusewicz, 1968). Only as a result of changes in density there may be diverse changes, mainly physiological ones, such as adrenal hyperactivity, change in proportion of cholinesterase in the cortex and subcortical region of the brain, change in thyroid activity and direct destruction of histological structures (for example, the renal tubules). The consequences of these changes have not yet been definitively determined, although many of them (particularly behavioral ones) can be predicted, at least in cell populations (Archer, 1970; Christian, 1971).

T. V. Koshkina et al. (1972) submit some interesting data on behavioral changes in the northern redbacked vole, in the aspen and fir tayga of the foothils of the Salairskiy range and Kusnetskiy Alatau. In both regions, during years of maximum increase in number there is a decrease in areas inhabited by the voles, more overlapping, greater migrating activity, particularly of young animals, and increased aggressiveness. The distribution of the population in the area changes in relation to population density. According to the data of I. A. Shilov (1972), during years of low number, the stress level in adult males diminishes as a result of less activity and aggressiveness.

Thus, organization of populations may be of decisive significance in the life of a population; this organization emerges as structure (age, sex, spatial, i.e., distribution in the area and configuration of individual areas and parceled groups) on the one hand, and intrapopulation processes (antagonistic and tolerant relations, protection of territory, activity, sexual relations, etc.) on the other.

Another important aspect and result of the direct and indirect effects of toxic chemicals are changes on the biocenotic level: disruption of biocenotic relations established in the course of evolution. Extermination of even one species (let alone several) leads to a change in the entire community and cannot help but affect all its members to some extent or other. Unfortunately, there is only scattered information on this complex question.

Not infrequently, spurts of reproduction and intensive increase in number of even the species against which insecticides and herbicides were used are the result of use of these agents. Such facts have already been observed with regard to 50 insect species. A decrease in number of natural enemies is one of the chief causes of mass scale reproduction of insect pests. Current studies refer primarily to the death of useful carnivorous insects due to toxic chemicals, and they do not discuss the biocenotically determined reduction in their number due to the lack of food. After a severe depression, the population thereof is restored much more slowly than the population of victims.

A sharp reduction in number of predatory birds has been noted in many countires (Starker, 1964; Clement, 1965; Ash, 1965; Waterston, 1965); these birds are the last link in the feed chains of biocenoses that receive a maximum amount of toxic chemicals through their victims. Rudd (1964) lists the following typical distribution of residual pesticides (mg/kg) in various organisms, as related to their position in feed chains:

| | | |
|---|---|---|
| Algae | Taxophen | 0.1-0.3 |
| Daphnia | " | 0.2; DDE 0.7 |
| Small fish | " | 3.0 |
| Large fish | " | 8.0 |
| Fish-eating birds | " | 39.0; DDT 138.0 |

However, accumulation of toxic chemicals in feed chains is only one aspect of the biocentoic problem, and it is probably the best studied. Rudd, for example, devotes an entire chapter in his monograph to the problem of accumulation of pesticides in feed chains. At the same time, more important aspects remain little-studied. Only a few facts are indicative of impairment of feed chains. Thus, after using DDT in a dosage of 1.12 kg/ha, no direct toxic effect on birds was observed; however, due to death of insects, the birds were forced to abandon the treated area (Kendeigh, 1947). A decrease in number of marine organisms due to toxic chemicals resulted in a decrease in number of fish (Hoffman, Merkel, 1948; Hoffman, Linduska, 1949).

Poisoning and death of various animals constitute only the beginning of disturbances in the biocenosis occurring as a result of extermination of one or several species. First of all, the feed relations are disrupted. As an example, there has been a meticulous study of the chain of biocenotic changes as a result of extermination of great gerbils using bait with zinc phosphide in Priaral'skiye Karakumy (Naumov et al., 1972). The sharp reduction in number of rodents causes predators to turn to other objects and hunting regions. Their mobility and concentration increase in areas where the rodents have been preserved. Their effect on the population of preys increases due to concentration in small areas. Then there is a sharp reduction of number of the predators themselves. The nests of long-legged buzzards and steppe eagles become empty. In the spring of the following year after extermination of great gerbils, some of the nests are not used at all, while others with eggs already in them are abandoned by the birds. The number of predatory mammals decreases by dozens of times.

Considerable changes take place in spatial correlations. Death of inhabitants of burrows and their prolonged absence leads, sooner or later, to destruction of these complex shelters. They are destroyed at a different rate, depending on the structure of the soil and weather, but many of the passages disappear within 1.5-2 years after the inhabitants die, and burrows can be detected only by the specific microtopography and zoogenic vegetation (Dmitriyev, Lobachev, 1973). At the same time, there is a sharp decrease in number of all inhabitants of burrows, first of all of animals that do not dig burrows themselves. The sharp decrease in number of ectoparasites after successful extermination of great gerbils is the result of three biocenotic factors: death of the main hosts, death of additional providers and destruction of shelters. In some cases, these factors are more effective than special extermination of insects from burrows. On the whole, the general fauna is impoverished. The number of many species decreases to a greater extent than the number of the species subject to extermination.

Some toxic chemicals alter significantly the animals' living conditions, due to their purpose. Thus, after treatment with butyl ether 2,4-D, a brush [low forest] area changes into deadwood (Skokova, 1973). This disruption of the biotope cannot help but affect the existence of the animal kingdom. Unfortunately, we have virtually no works on the effects of insecticides and rodenticides on primary productivity of communities.

It is quite obvious that the changes occurring in biocenoses are quite diverse and specific for each concrete community. It is assumed, for example, that pesticides may have a particularly severe effect in the tundra (Shilova et al., 1971), as well as, incidentally, in other young and unstable biocenoses. Such interesting biocenotic questions as changes in spatial correlations of animals, vegetation, soil, habitats, are still virtually unpredictable. The systems of species-related and particularly biocenotic levels are notable for less integration of elements, higher mobility of composition and lack of clearcut spatial boundaries, as a result of which there is extensive interpenetration of adjacent systems. On the one hand, this provides for their continuity and general homeostasis (Naumov, 1971) and, on the other hand, it complicates the diversity of reactions of these systems to exogenous factors.

## Conclusion

The influence of toxic chemicals can be traced on all levels, from the subcellular to the biospheric. It can be direct and toxic: poisons impair cell metabolism, prevent synthesis of enzymes, act like mutagens and carcinogens, which leads to death of the organism or sublethal phenomena. On higher levels of organization of living matter, both toxic and indirect, nontoxic, effects are observed. Unlike the former, they constitute esssentially a nonspecific reaction of the community to pesticides. In essence, this is the reponse to change in populations and biocenoses, related to disruption of correlations established through evolution.

Indirect changes of this type can occur in populations and biocenoses not only under the influence of toxic chemicals, but several other factors, for example, man's endeavors directed toward altering the landscape (plowing, cutting down trees, irrigation, etc.) or direct pursuit of animals (hunting, extermination). Different types of such activity can initiate an influence on different levels (pursuit of animals--on the organismic level, change in landscapes--on the biocenotic), but then, through the same links, they extend to all other levels (see Figure 1). Thus, it may be assumed that partial shooting of animals of some species will alter the population structure of this species, then the structure of the entire community. In this case, the physiological and behavioral changes are not the result of pathological changes in the animal organism, but the self-regulatory response of the population to the change in its structure.

Until recently, only the direct, toxic effects of toxic chemicals on fauna were studied comprehensively. Now, with the development of biocenology, and particularly since the works of Christian, Davis, Chitty, Petrusewicz and others revealed the presence of regulatory mechanisms in populations, it is becoming imperative to pursue studies on the population and biocenotic levels, which will help understand the entire depth of effects of toxic agents on fauna and mechanisms of self-regualtion. As a result, after a measured intervention by man, a natural community could serve as a model for the study of mechanisms of self-regulation in nature.

From the standpoint of biocenological changes, special attention should be devoted to economic studies. At the present time, estimation is usually made of the effects of pesticides on large or practically important animals, for examples those that are hunted and traded. Quite often, consideration is not given to the fact that a sharp reduction in number of other, seemingly unimportant, faunal representatives as a result of disruption of spatial and trophic connections on the biocenotic level could have a more devastating effect on valuable animals, than direct extermination thereof.

While most research on the organismic level can be conducted in the laboratory, the need for strict quantitative and time estimations of changes in populations and biocenoses raises the question of expanding complex work in the field. On the other hand, it has become necessary to corroborate, under field conditions, some of the factual data referable to the cellular and subcellular levels that were demonstrated through experimentation. This applies, first of all, to the carcinogenic and mutagenic properties of toxic chemicals. Work in these directions will make it possible to make a more comprehensive evaluation of the most diverse aspects of the effects of toxic chemicals on natural complexes.

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ERGONOMICS

## LEARNING OF MOTOR SKILLS FOR LABOR ANALYZED

Moscow TEKHNICHESKAYA ESTETIKA in Russian No 3, 1977 pp 10-13

[Article by E.I. Kochurova, psychologist, Moscow State University: "Study of the Changes in the Microstructure of Skill in the Process of Prolonged Training"]

[Text] Objective changes in the vocational structure of labor activity, connected with automation of production processes, has been expressed in the appearance of new types of operator labor for control of technological processes, automated systems, moving objects, robots, and manipulators, an essential component of which are complex forms of control activity. Automation has not only caused redistribution of physical and mental activity in the process of labor, having reduced the outlays of physical labor, but it has also changed the character of control activity, having made it considerably more complex, especially during control of moving objects. Not requiring great physical efforts the actions for control of an object are becoming complex for man, since they should be executed, as a rule, in a given time and with high accuracy [1]. Complication of the forms and types of actual control activity place new practical tasks before engineering psychology and ergonomics, for the solution of which it is necessary not only to develop research in these fields, but also to work out new methods of studying them.

In a number of papers V.P. Zinchenko and his colleagues [2, 3] describe methods of analysis of the functional structure of control activity using the example of a study of instrumental spatial action as one of the types of complex control activity. Use of these methods in the study of the process of formation of motor skills made it possible to single out cognitive and control functional blocks (blocks of functions): the block for formation of programs, block for realization of motor programs, and the block for control and corrections, comprising the functional structure of complex sensomotor activity. The main regularity revealed is that the formation of cognitive stages of action conditions perfection of the skill as a whole. The complex relations of the functional blocks in the process of skill formation reflect the important features in the course of mastery of an action [3].

Continued in our work was the study of the functional structure of the control action. Utilized for this was prolonged training and a break in training as methodical devices revealing changes in the microstructure of action. The study was conducted on a special experimental testing unit [3], making it possible to form an instrumental spatial motor skill for control of an object (a moving spot of light, square in form, on the screen of a television indicator) with the aid of a lever having, like the object, three degrees of latitude, that is, upon shifting the lever along the horizontal (X), along the vertical (Y) and down (Z) the spot on the screen is shifted along the horizontal, the vertical and changed in size. The test subject was given a task: upon command of the experimenter to control, using the lever, the moving spot on the indicator screen along the path denoted by three elements (squares of various sizes), with each of which it was necessary to make the spot coincide according to position (X, Y) and according to size (Z), and having accomplished coincidence to press the button located on the control lever. Presented in the course of one experiment were 250 trial-routes.

Upon transfer from one element of the path to another there was a recording of the movement along the three coordinates X, Y and Z in the form of curves, on each of which it is possible to isolate the stages of action: latent, phase (strictly movement), control and corrections. Determined on the basis of the data obtained was the time of fulfillment of the transition to one element of the path and the average time of each stage of action as the arithmetic means along three coordinates, and also computed was the percent content of each stage in the integral action. Since each stage of action was represented in time along three coordinates, the average spread in time for an individual stage was computed as the arithmetic mean from the sum of the three differences between pairs of coordinates (X and Y; X and Z; Y and Z).

Formation of a skill under the conditions of compatibility of the perceptual and motor fields was performed at first in the course of 10 experiments, then there was a three-month break, after which the skill was restored and improved up to the accomplishment of stable results according to the time of execution of the action. The obtained results were considered on three levels of analysis: macro-analysis, micro-analysis and microstructural analysis [3].

Macro-analysis of the data of formation of a skill during prolonged training indicates that the time of fulfillment of the transition from one element of the path to another is decreased rapidly in the first experiment and considerably more slowly in subsequent ones, which on the whole is reflected by a learning curve with an exponential character (figure 1). Prolonged training over the extent of 17 experiments (4,250 trials) revealed, in addition, a wave-shaped character of formation of the time of execution in the period of accomplishment of the action: first it is increased, then it is decreased, then it is again increased. And only in the last experiment does stabilization of the time of execution begin, since the time of the first trials is equalized and the time of the last

trials, reaching 1.0 seconds, becomes constant also. This wave-shaped character of the process is revealed not only according to the results of the first and last trials, but also for the learning curve compiled for each experiment. Here, characteristic for the action formed is a high level of automation, expressed, in particular, in that the path made up of three elements began to be executed as a unified, combined process.

The obtained shape of the curve can be interpreted differently and with multiple meaning in the limits of macro-analysis and observation of qualitative changes in the action coming from outside. The question of the relation of the shape of the learning curve, plotted according to different indicators, to the changes in qualitative aspects of the action occurring according to the degree of training, was solved in different ways by the researchers. The shape of the curve was was connected with with a definite hierarchy of skills of a lower and higher order and with mastery of the tasks facing the test subject not as a whole, but according to sub-tasks, both with a shift in the methods of work in the process of performance of the skill, and with replacement of visual control by kinesthetic, and so on [4-7]. It is possible that all these features are present in the process of formation of the skill, and in different studies, depending on the complexity of the skill studied and the methodical organization of the training it is possible that different factors may emerge as decisive ones, but the recording devices used do not make it possible to make a final conclusion about any of them. In addition, taken as indicators were different data about the process of formation of the skill: the time of execution, number of trials necessary for achievement of a certain criterion, number of errors, trajectory of movement -- which reflect in different ways the variations in fulfillment of the assignment [4]. Thus, on the level of macro-analysis it is difficult to obtain unambiguous data on the process of formation of a skill and, the more so, to interpret them unambiguously.

Utilization of micro-analysis makes it possible to overcome these difficulties to a significant degree. Isolation of individual stages -- latent, phasic, and the stage of control and corrections realized by corresponding functional blocks -- in the integral action with the help of micro-analysis makes it possible to penetrate the structure of the action formed. In addition, since micro-analysis is directly connected with macro-analysis, it is possible to interpret more interestingly the process of formation of the integral action and approach explanation of a number of phenomena observed in the learning process on the basis of significantly more detailed information. Experimental data obtained on the level of micro-analysis make it possible to reveal changes in time occupied by individual functional blocks: the program formation block (PFB), the realization block (RB), the block of control and corrections (BCC). As the results show, the time for PFB remains without change, for the RB it is reduced by 30 percent, and for the BCC it is reduced by 77 percent. Thus, the BCC underwent the greatest time changes, but against the background of the identical directivity of time changes of RB and BCC toward a reduction, the PFB does not detect such a tendency. In addition, the results of micro-analysis

indicate that each functional block is characterized by its own time dynamics: so in the absence of time changes for one block, changes in time can occur for another block or two blocks. With respect to the directivity of the changes, the time dynamics of RB and BCC coincide to the greatest degree with the time dynamics of the learning curve obtained according to the data of macro-analysis.

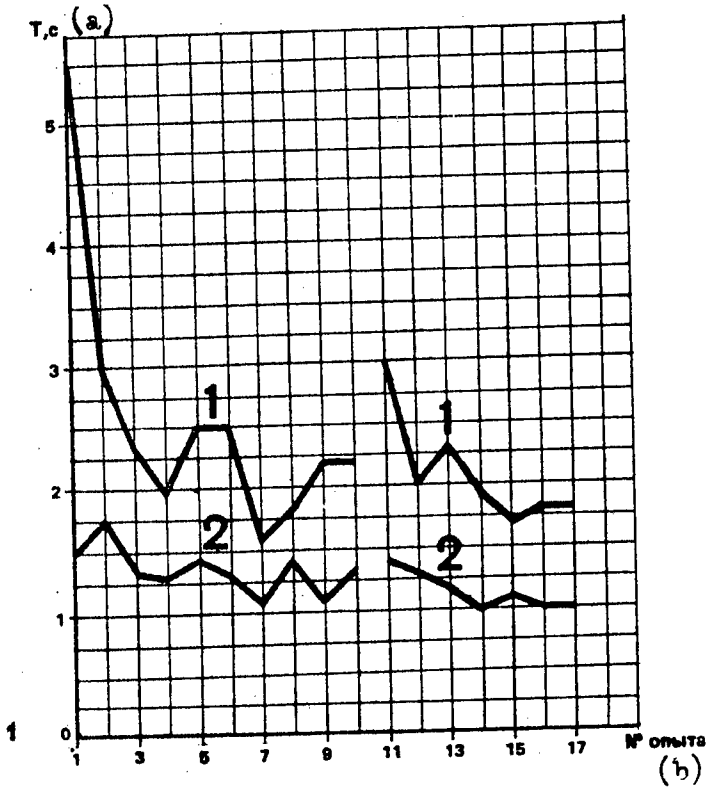
An interesting indicator characterizing the formation of a skill is the distribution of time among blocks of functions in an integral action, presented for each block in percents. It yields the opportunity to evaluate the role of each block in the integral action and to follow the changes occurring in the microstructure of the action according to the degree of mastery of the skill. As is shown by the data obtained, the share of the PFB in the integral action (figure 2) gradually increases, but the share of the BCC is reduced, and in this case the share of the RB is first increased then decreased. These data show that the cognitive blocks PFB and BCC are subject to the greatest changes. The relative growth in the share of the PFB in the integral action indicates the determining significance of the image of the situation taking shape and the motor program of action at all stages of mastery of the skill. According to the degree of formation of the image its regulative function grows, which is indicated by the rapid and considerable reduction in the share of the BCC.

It is natural that control is accomplished more easily the clearer the established image of the situation in which the action is being done, and the more accurate the program of its realization. The growth in the regulating function of the image is indicated both by the absolute reduction in the time falling to the RB, and the fluctuations in its specific weight in the integral action.

Not analyzed in our research is the process of establishment of the functional structure of the studied action, which occurs at the very beginning stages of training. The results obtained are interesting in the sense that they show the changes (absolute and relative) of the individual components making up the established and relatively invariant functional structure.

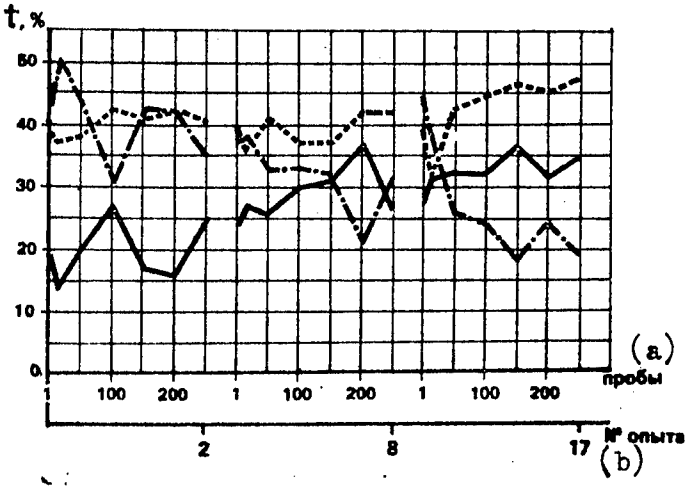
The changes taking place in the functional blocks, regarded as components of the functional structure of an action, are very essential in the process of formation of a skill. The relationship of the components in the structure of the action even in the second experiment is established as follows: PFB, 20 percent; RB, 40 percent; BCC, 40 percent. As a result of the training we obtain an essentially different relationship: PFB, 35 percent; RB, 45 percent; BCC, 20 percent. In this way, the changes in the action in the process of its formation are expressed, basically, in an increase in the share of the PFB and a reduction in the share of the BCC (see figure 2).

It is correct to raise the question of whether the quantitative changes occurring with individual components of the integral action lead to a change in its functional structure or whether the latter remains unchanged. In order to answer this question, it is necessary to turn to the data of microstructural analysis.




Key:
a. T, seconds
b. Number of experiment

Figure 1. Macro-analysis: learning curve compiled according to the time of execution (T) in the first (1) and last (2) trials of each experiment.




Key:
a. Trials
b. Number of experiment

Figure 2. Micro-analysis: relation of the functional blocks (time, t) in the integral structure of action: PFB -- solid line, RB -- dotted line, BCC -- dot-and-dash line.

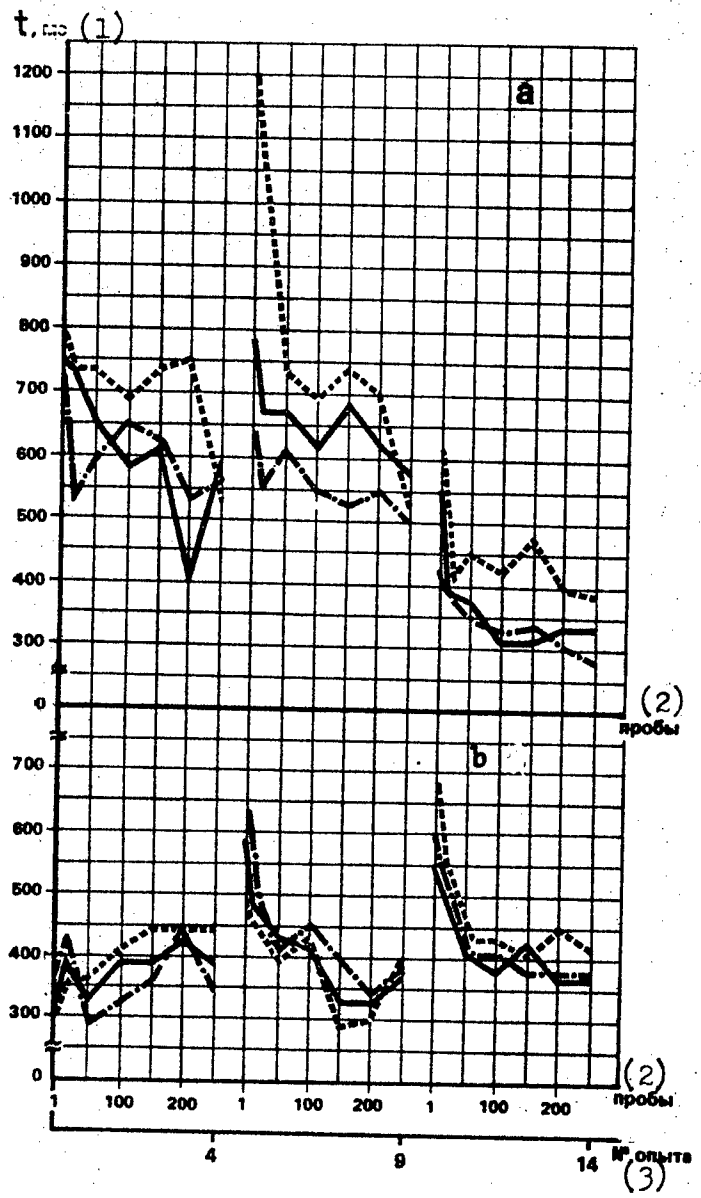



Figure 3. Microstructural analysis: time spread between components X (dot-and-dash line), Y (solid line), and Z (dotted line) of spatial action in the PFB (b) and RB (a).

Key:

1. Time, milliseconds
2. Trials
3. Number of experiment

The microstructural level of analysis makes it possible to reveal changes occurring in each functional block in the process of skill formation. Since the formation of the programs and the realization of the movement along components X, Y, and Z of spatial action is not accomplished simultaneously, a time spread is formed, which is reduced, as was shown by the studies [3], according to the degree of mastery of the action. More extended training showed that a decrease in the spread can be replaced by a certain increase, after which a still greater decrease in it follows. This coincides with the decrease in the overall time of execution, where the following relationship is observed: a decrease in the time of execution is accompanied by a decrease in the time of the spread, then on the background of a constant time of execution the time spread continues to decrease, and after the new reduction in the time of execution a further reduction in the spread is observed. As a result the time spread for each functional block is fixed at a definite level.

Reduction in the spread indicates that the functional blocks overlap one another less and less and the limits between them in the structure of action become more and more distinct [3]. Establishment of the spread at the minimum and, as N.A. Bernshteyn wrote [8], further unavoidable level, apparently, indicates the achievement of a certain limit not only in the spread but, possibly, also in accomplishment of the action. The last circumstance is very important for labor training.

The noted connection of the reduction of the time spread with the reduction in the time of execution, and then the changes in the time spread on the background of a constant time of execution yields the basis to assume that the spread is an expression of complex transformations of the action directed to a search for the optimum relations between the component coordinates of the spatial action. And the first step toward disclosure of these relations can be analysis of the primary data about the relation of components X, Y, and Z in the process of execution of the action (figure 3).

In the course of execution of the action the formation of the program for the components occurs differently -- at first X, Y, Z, then this order is disrupted: it can end for each component both in the first as well as the last turn, after which a definite order can again appear.

The relationships between the components in the RB have another character. In the beginning of establishment of the skill the movement also ends in sequence according to components X, Y, Z, but observed according to the degree of perfection of the action is a tendency toward simultaneous accomplishment of the movement for all the components, and then the initial order between them disappears. In this case in the course of formation of the skill various relationships of the components in the RB are observed: one ends first of all with movement along X, and them almost simultaneously along Y and Z, for the other at first the movement is completed along components X and Y and somewhat later along Z. The last relationship of the components is retained for quite a long time. In addition, these relationships of the components regularly alternate with the sequence X, Y, Z.

The obtained data show that the successiveness of involvement of the components, observed in the first experiments, is replaced by relative simultaneity for X and Y with a certain lag for Z which, apparently, should be replaced by more complete simultaneity of action along the components. But in our experiments this is traced to the greatest degree just in the PFB and to a somewhat smaller degree in the RB.

Improvement in the action, expressed in a reduction in the total time of fulfillment and the spread, is accompanied by alternation of different relations between the components (X, Y, Z) both in the PFB and in the RB; it is probable that the search for new possibilities for improvement of the action occurs in the periods when the components are organized in the sequence X, Y, Z, since reduction in the time of execution and the spread falls in these periods. It is necessary to note that this process does not occur simultaneously in the program formation block and the realization block.

Since at the initial stage of training the formation of the programs according to the components finishes in sequence and completed with a still great delay is the movement along the components, an overlapping of one block by another is formed, as a result of which singled out on the time axis of the process are two zones of the spread -- one at the border of PFB and RB, and the other at the border of RB and BCC. According to the degree of formation of the skill, these zones are reduced and the time spread between the components remains minimal, showing that the formation of the programs, the realization of them, and the control are not accomplished absolutely simultaneously.

As was pointed out above, the next series of experiments was conducted after a three-month break.

Macro-analysis of the results showed that even in the first experiment the skill reaches the level at which it was in the eighth experiment before the break. Required for full restoration of the skill was approximately 20 percent of the time from the previous training. Improvement of the skill was observed in subsequent experiments. Micro-analysis of the results practically confirmed the data of the macro-analysis.

Microstructural analysis showed that the interruption in the work affected most of all the values of the spread, which are restored only in the third experiment after the break. This indicates that the value of the spread reflects the most complex and delicate relationships in formation of the action.

Comparative analysis of the data obtained at various levels of the analysis yields the opportunity to approach an explanation of a number of facts relating to the problem of formation of skills, and to single out a number of the stages of this process. Occurring at stage 1 is the formation of the primary structure of the action on a background of a sharp decrease in

the time of its execution and spread. The primary structure of the relation of the functional blocks is still blurred, unstable, there is a large zone of overlapping between the blocks. Developed for the most part at the first stage is the block for formation of programs of motor instructions. At the second stage with fluctuations in the time of execution and the spread there occurs successive development of the other blocks. Improved are the block for control and corrections and the realization block, as a result of which a relatively stable structure of action is formed. At the third stage in the framework of the acquired structure of action there occurs further improvement of its components and redistribution of the time which they occupy in the integral action. Stabilization of the time of execution and the spread occurs.

The obtained results can be interpreted in the following way. The most important stage in formation of a motor skill is selection of the components and establishment of the relations and interrelations between these components. When the components have been selected, when the sequence of their inclusion in time and space has been established, this designates formation of the functional structure of the required action. Namely the functional structure will become the object of memorization (engramming). Improvement in the functional structure occurs owing to the components making it up, and not owing to changes in the previously established structural relations between them. This does not exclude that the action, having one and the same functional structure, can be performed either unskillfully, unaccurately, or excellently and precisely. The progress in our case is attained owing to development of individual functional blocks.

Introduction of a long gap does not dead to decay of the functional structure of the action as a whole, but leads to worsening of the components making it up. The latter is expressed both in the slowing down of the accomplishment of the functions, performed by a corresponding block, and in the lowering of the quality of execution of these functions which is shown, in particular, in the increase in the magnitude of the spread.

The results obtained indicate that the methods of microstructural analysis are an adequate means of control both over the course of formation of a motor skill and over the course of its restoration.

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# THE TACTICS OF INDIVIDUAL INVESTIGATIVE ACTIONS

Moscow SOTSIALISTICHESKAYA ZAKONNOST' in Russian No 6, 1977, pp 61-64

[Article by A. Vasil'yev, doctor of juridical sciences, professor]

[Text] A system of tactical procedures that is developed not for every investigative action as was the case traditionally earlier, but on the basis of employment of these or those data of the special science and generalization of investigative practice, creates the possibility for broader and more effective use of tactical procedures in an investigative action.

The three types of tactical procedures developed thus, that is, on the basis of scientific organization of labor (NOT), psychology and logic, make it possible to employ them in all investigative operations for collection of evidence.

If such tactical procedures become firmly established in investigative practice, the scientific equipment of the investigative officer is enhanced significantly and the quality of the investigation is improved.

Tactical procedures based on NOT find their fullest employment in the inspection of the place of an incident. Let us examine their general content and specific character of employment on the example of this investigative action so that when bringing up other investigative operations it will not be necessary to return again to a general characterization of these tactical procedures.

The tactical procedures based on NOT consist of planning and hitherto not practiced in the capacity of tactical procedures mobilization and distribution of forces; cooperation of investigative and operative-search operations, organization of investigation of the material setting. All of them, with the exception of cooperative action may be used on a full scale in every examination of the place of an incident, while cooperative action is employed only where a need exists for it.

In the planning of an inspection of the place of an incident, a problem usual for all investigative operations arises--to stipulate place and time for carrying it out, preparatory measures, make-up of participants, and the like. It is necessary to determine in advance or in the course of this investigative operation the use of tactical procedures--mobilization and distribution of forces, cooperation with operative-search actions and organization of investigation of the material situation.

What constitutes the tactical procedure of mobilization and distribution of forces and why is there a need for it? A large group of people may take part in an examination of the place of an incident. But the law specifies the purpose, rights and obligations only with respect to attesting witnesses, the specialist and counsel for the defense if he is permitted to take part in the investigation. The role and specific duties of other possible participants--operative personnel of the militia, departmental inspectors, representatives of the administration, if the operation is conducted in a building or on the premises of an enterprise or institution, defendants, suspects, witnesses, victims, representatives of the public--are determined by the investigating officer.

Operative personnel of the militia, representatives of special inspectorates may have their tasks, interests in the investigation of the commission of a crime, but in an investigative examination, as in other investigative actions, everything and everybody are subordinated to the objectives of this action and the guidance of the investigating officer.

The role of representatives of the public in the investigative action should not be reduced to the performance of purely technical subsidiary errands of "give," "bring" and the like. On the contrary, they should display here their initiative, activeness, interest in performing the role assigned to them, for example, in searching for traces of a crime, finding witnesses to its happening and so on. Only under such conditions would the participation of representatives of the public in an investigation be of help to the investigating officer and bring moral satisfaction to themselves.

Special attention should be given to involving suspected persons, for example, the driver of a motor vehicle in the case of a pedestrian being run over, victims, where their physical condition makes them available, certain witnesses, in the inspection of a place of an incident. Their participation is justified only to the extent that they can be of assistance to an objective, recording of the conditions of the place of an incident, determination of the true circumstances of an incident and where their personal interests are of no hindrance to this. Their testimony concerning the place and course of an incident, its participants, these or those circumstances is frequently helpful in establishment of details, significant particulars of an incident. The report of an examination must reflect only findings that confirm or refute this testimony.

The cooperative operation of investigative and operative-search actions as a tactical procedure is in no way an operative-search action (use of an auxiliary dog, pursuit, observation, ambush and the like), being a responsibility of inquest organs, their sphere of activity, which is regulated by departmental acts. The tactical procedure of cooperative operation is a mutual combination of these or those actions on the condition that operative-search actions play an auxiliary role in regard to investigative actions.

The tactical procedure of cooperative assumes four forms: (1) determination with the aid of an operative-search action of the need for carrying out an investigative action (for example, search, interrogation or examination of a person singled out by an auxiliary dog engaged in following a spoor; (2) creation of favorable conditions for an investigative action (for example, "reconnaissance" with reference to an object subject to search); (3) parallel accompaniment of an action (for example, organization of pursuit of criminals simultaneously with examination of the place of incident); (4) development of results of an investigative action (for example, initiation of observation of persons who, after a robbery, may possibly be attempting to escape with property).

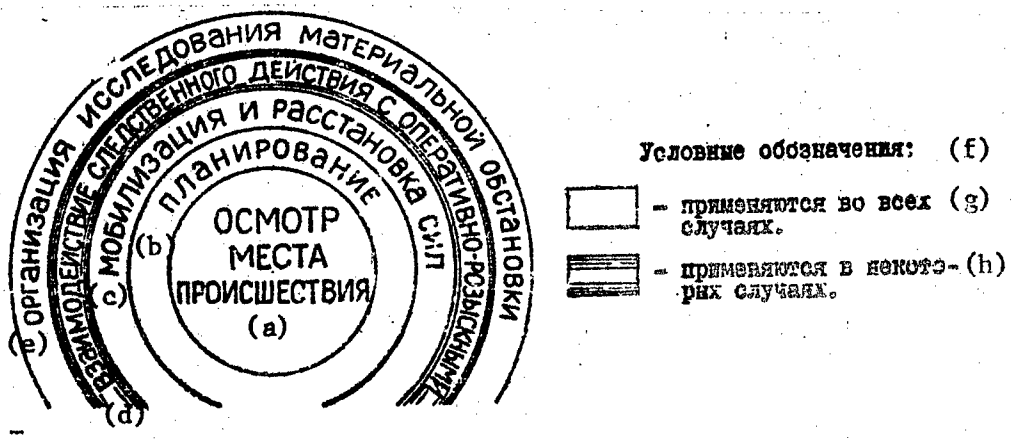
Such cooperation is underestimated by many investigating officers, and it is not widely used simply because they do not take into consideration the forms of cooperation and their possibilities. A specific situation may suggest to an investigating officer what form of cooperation it would be advantageous to use in a given situation so that together with the auxiliary character of operative-search actions, investigative actions in their turn create for them possibilities and conditions for broad application.

The organization of an investigation of the material situation includes: determination of the limits of examination, a preliminary survey to become familiarized with the situation, selection of a direction of procedure in the investigation, a systematic approach to investigation of the components of the situation, the combination of static and dynamic methods of investigation.

In the examination of the place of an incident, other kinds of tactical procedures may be used, particularly those based on the psychology of relations between the investigating officer and the participants of the investigative actions. These procedures find their fullest employment in the interrogation.

In every interrogation, it is impossible to avoid the establishment of a psychological contact by means of persuasion and criminological analysis of the testimony. The need arises in some cases, however, for the procedures of offering psychological assistance of bringing back to memory what was forgotten and reproducing what was perceived and, sometimes for methods of psychological influencing through persuasion for the purpose of overcoming a negative position and obtaining truthful testimony. Tactical methods on the psychology of relations are also employed in other investigative actions

Tactical Procedures Based on Scientific Organization of Labor (NOT), on the Example of Examination of Place of Incident




Key:

(a) Examination of place of incident
(b) Planning
(c) Mobilization and distribution of forces
(d) Cooperation of investigative action with operative-search
(e) Organization of investigation of material situation
(f) Legend:
(g) used in all cases
(h) used in some cases

in which they were not used formerly. In particular, the establishing of a psychological contact applied formerly only to interrogation. The system described here stems from the fact that it is impossible to carry out a single investigative action without psychological contact. Such a contact contributes, if not to the obtaining of truthful and complete testimony (this may not occur within the context of an investigative action, for example, in a search), at least to the creation of a favorable psychological microclimate in which every participant fulfills conscientiously his procedural and moral responsibilities and the specific role assigned to him and utilizes correctly his procedural rights in the interest of a successful solution of the objective of an investigative action. In all investigative actions, such methods of establishing contact as communicable behavior on the part of the investigating officer (tactful personal behavior, an attentive attitude in informing every participant of his role, rights and responsibilities, creation of normal external relations and so on), stimulation of interest and of helpful activity in each person participating in the action, dissipating of a possible conflicting mood in individual participants can only be welcomed.

The most difficult of this group of tactical procedures is that of influencing directly psychologically an individual giving testimony with a negative

Technical Procedures Based on Psychology, on the Example of an Interrogation


Условные обозначения: (f)
- применяются во всех случаях. (g)
- применяются в некоторых случаях. (h)

Key:

(a) Interrogation
(b) Establishment of a psychological contact
(c) Criminological analysis of testimony
(d) Rendering psychological assistance
(e) Psychological influence in overcoming a negative position and obtaining truthful testimony
(f) Legend:
(g) used in all cases
(h) used in some cases

attitude that has to be overcome in order to obtain truthful testimony (see table). The procedure consists of finding contradictions in the testimony, disclosing their falsity and contradictions between testimony and other evidence, of finding and eliminating reasons that serve as a bar to truthful testimony, of motivating the positive sides of the individual giving the testimony. The specific character of this procedure calls for an attentive analysis of the testimony. Of course, one should keep in mind the character of the person giving the testimony, his position and role in the case, as well as specific investigative situations.

Of the tactical procedures based on logic, broad use is made in an investigation only of the investigative version, especially in the general planning of the case as a whole. Practical use of investigative versions in individual investigative actions is a rare phenomenon. Of course, if one were to understand an investigative version as being a simple surmise of the investigating officer which actually occurs in the process of an investigative action and is simply checked out and resolved immediately (for example, it may be assumed that the felon entered through a window, and this assumption is checked out by an examination of the windowsill, floor, and ground for detection of tracks), then truly such versions arise in almost all investigative actions. But the investigative version is not just a simple assumption but a complex analytical program that includes the construction of an exhaustive

sphere of possible versions, their verification by means of deduction through the development of all realistically possible investigations and so forth. Consequently, such a procedure in the process of an investigative action is most difficult.

In separate investigative actions and in the evaluation of their results, wider use is made of inductive inferences for the purpose of being able to consider this or that circumstance as established. Such a conclusion based principally on the recurrence of similar factos, while it may be within the framework of an assumption, makes it possible in practice to proceed in an examination as from an established circumstance, provided no basis is found subsequently for a different evaluation.

Regardless of the fact whether investigative induction is acknowledged as a tactical procedure, in the tactics of individual investigative actions, the role of an inductive conclusion, as an important means of tallying their results and progress in the elucidation of the circumstances of the case, could not possibly be overestimated. For example, in the summertime the body of a man is found in a wooded grove with signs of blows inflicted on the head with a chopping tool; death occurred four-five days previously. The investigating officer, without having to think very hard, may then conclude that the crime was committed at that particular place because, aside from the body, they found the remains of food and tracks of two people. But such a conclusion could turn out to be fallacious. And this the investigative officer could have avoided had he used inductive thinking in solving the problem of the site of the murder. How is this done? First of all, it is necessary to isolate the most important indications in the initial data from the cognizable event (A)--the premise of the inference (B). In this case, these could be: onset of death four-five days previously; from the indicated cause; the amount of blood on the clothing and on the ground under the head of the body corresponding to an injury of this kind; location of spots on the body, the relative position of the body; the condition of the grass under the body corresponding to the presence of the body in this place for four-five days; absence of any traces of the body being dragged to the place of its discovery; absence of traces in the surrounding area indicative of the possibility of such a happening at another place of this location; absence of other circumstances contradicting the occurrence of the murder at the spot of the finding of the body.

Thus "A" will equal "B" (in relation to the elucidation of the given circum stance--the site of the murder). At the same time, the investigating officer will construct in thought a so-called rule of deduction (C). On the basis of practice and scientific recommendations, as though abstracted from factually disclosed data at the place of incident, he will see such an exhaustive combination of "C" indications as to consider them objectively sufficient

for the conclusion that a murder was committed at the place of discovery of a body in a similar setting. If it should prove possible, after determining that "A" = "B", to construct another set "B" = "C", then naturally it follows that "A" = "C". Consequently there is no need to be afraid of an error in the conclusion that the murder was committed at the place of discovery of the body and to use this as a point of departure in further investigation.

The working out of typical situations--"collections" of indications making it possible to come to a conclusion on the establishment of specific circumstances through inductive inferences, constitutes one of the tasks of the tactics of investigative actions and a method of investigation of separate types of crime.



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# MOLECULAR STRUCTURE, REPLICATION OF BACTERIAL PLASMIDS

Moscow USPEKHI SOVREMENNOY BIOLOGII in Russian No 3, 1977 pp 323-339

[Article by I. P. Vorob'yeva, S. L. Bogdanova and I. A. Khmel' (Moscow), Institute of Atomic Energy imeni I. V. Kurchatov]

[Text] Data are submitted on the classification, molecular nature of bacterial plasmids and amount of plasmid DNA in cells. There is comprehensive discussion of replication of plasmid DNA, the role of various DNA polymerases in this process and replication mutations. A comparison is made of distinctions of replication of large and small plasmids, and the bacterial chromosome.

Bacterial cells may contain other genetic elements, in addition to chromosomes, that supplement the system of chromosomal inheritance. The genetic elements that are stably present in the cell in an autonomous, i.e., extrachromosomal, state are called plasmids. Many of them can build themselves in the chromosome of the host bacterium; in this instance, they are reproduced as part of the bacterial genome. Plasmids that are capable of existing in cells in both an autonomous and integrated state were named episomes (Clowes, 1972; Meynell, 1972). Plasmids are not necessarily present in the bacterial cell; however, they can determine such important bacterial properties as capacity to transmit genetic material and synthesize specific antibacterial substances--bacteriocins, resistance to antibiotics and other drugs, etc. For this reason, it is mandatory to investigate bacterial plasmids to solve various theroetical and practical problems.

Interest in bacterial plasmids increased even more, since they have now become the main objects of work in gene engineering. The potential of using plasmids in this rapidly developing branch of molecular biology and genetics is determined by the following reasons: 1) using specific endonucleases (restrictases), it would be relatively easy to build plasmids with a specific set of genes in vitro; 2) plasmids can be transferred to the cells of desirable recipients through conjugation, transformation and transduction; 3) the dosage of required genes can be increased by many times and the levels of their products can also be increased by means of plasmids that are present in the cell in a large number of replicas [copies].

More recently, brilliant advances have been made with regard to in vitro development of hybrid plasmids with bacterial and phage genes, as well as genes of higher organisms (Cohen et al., 1973; Chang, Cohen, 1974; Hershfield et al., 1974; Morrow et al., 1974; Timmis et al., 1974, 1975; Alikhanyan et al., 1975; Kedes et al., 1975; Grunstein, Hogness, 1975; Lovett, Helinskik 1976; Skurray et al., 1976; Struhl et al., 1976). It is quite apparent that plasmids can be successfully used in gene engineering only if their molecular nature and function in bacterial cells are submitted to in-depth investigation. Furthermore, bacterial plasmids may be convenient objects for the study of replication and transcription of DNA, since the small size of plasmid DNA makes it possible to isolate them in intact form and use them to analyze these processes in vitro.

## Main Groups of Bacterial Plasmids

Many microorganisms of different genera and species contain plasmid DNA. The plasmids encountered in Enterobacteriaceae strains have been studied the best; Staphylococcus and Psuedokonas plasmids are also being investigated intensively. Studies have begun of plasmids of Bacillus, Agrobacterium, etc. Three main groups of plasmids from enterobacterial cells have been described the most completely (Jacob, Wollman, 1961; Meynell et al., 1968; Kudlay, 1969; Novick, 1969; Clowes, 1972; Meynell, 1972; Hardy, 1975).

Sex factors (F factors): The presence of these plasmids transforms the bacterial cell into a genetic donor, i.e., it confers the capacity to synthesize sex pili and transmit genetic material of the plasmid and chromosome to recipient cells through conjugation. F factors are characterized by derepressed synthesis of sex pili, as a result of which there is a high incidence of plasmid transfer in conjugation. The F factor can integrate in the chromosome of Excherichia coli and determine transfer of chromosomal genes; changing to an autnomous state, occasionally the F factor captures the chromosomal genes and incorporates them (For example, F' factors: F'lac, F'gal).

Multiple drug resistance factors (R factors): Cells carrying these plasmids become resistant to various drugs and antibiotics, for example, sulfamides, penicillin, chloramphenicol, streptomycin, tetracycline and many others. There are R factors that control resistance to some colicins (Siggardi, 1966), metal ions (Smith, 1967; Summers, Sugarman, 1974), and some that code synthesis of specific endonucleases (Meselson et al., 1972). Both transmissible(with sexual activity) and nontransmissible plasmids are encountered among R factors. In transmissible ones, synthesis of sex pili is usually repressed, and the incidence of their transfer is low. Some R factors can become incorporated in a bacterial chromosome (Moody, Runge, 1972; Yoshikawa, 1974; Goebel, 1974; Terawaki et al., 1975).

Colicinogenic factors (Col factors): These plasmids determine synthesis of specific proteins of colicins, antibiotics with a narrow spectrum of action. At the present time, more than 25 different colicins are known, each coded by its own plasmid and acting specifically on macromolecular

synthesis of sensitive cells. There are transmissible (Ia, Ib, B, V) and nontransmissible (E1, E2, E3) colicinogenic factors, the transfer of which into recipient cells can be mobilized by plasmids with sexual activity. Synthesis of sex pili is repressed in cells with ColIb, ColB, and derepressed in cells with ColV. Some Col factors (ColV, ColB) may become incorporated in the bacterial chromosome (Moody, Runge, 1972; Kahn, 1973).

We know of many other plasmids not contained in these main groups, and they are presently being investigated intensively. They include Hly plasmids, which code synthesis of α- and β-hemolysin in E. coli cells (Goebel, Schrempf, 1971; Goebel et al., 1974); Ent, which code synthesis of enterotoxins (Smith, Halls, 1968; So et al., 1975); K88 plasmids, which are responsible for synthesis of surface antigen K88 (Ørskov, Ørskov, 1966; Leth et al., 1972); the penicillinase plasmid from Staph. aureus (Rush et al., 1969); Pseudomonas plasmis, which determine the cell's capacity to utilize octane, naphthalene, camphor, salicylic acid (Chakrabarthy, 1972, 1973, 1974; Dunn, Gunsalus, 1973; Boronin et al., 1976; Palchaudhuri, Chakrabarthy, 1976; Williams, Worsey, 1976). We must also mention the numerous cryptic plasmids found in cells of diverse microorganisms, whose functions are not yet known (Cozzarelli et al., 1968; Lee, Davidson, 1968; Carlton, Helinski, 1969) and plasmids that are derivatives of temperate phages: P1-like plasmid (Ikeda et al., 1970) and λdv (Matsubara, Kaiser, 1968); however, we shall not be dealing here with phage plasmids or phages.

It should be mentioned that the classification of bacterial plasmids has not yet been refined. Transmissibility or nontransmissibility may be considered the most important plasmid feature for classification purposes. Transmissible plasmids are divided into two types, according to specificity of sex pili: F-like (F, ColV, ColB, some R factors) and I-like (Ib, Ia, and some R factors). The pili of these two types differ in morphology, antigenic properties and receptors for phage adsorption. F pili adsorb spherical (f2, Qβ, MS2) and filamented (f1, fd) F-specific phages; I pili adsorb only I-specific phages (If1, If2)(Novick, 1969). Further, transmissive plasmids are divided into $fi^+$ and $fi^-$ (fertility inhibition), depending on whether they depress sexual function of the F factor when introduced in an $F^+$ strain due to the action of a repressor of a superinfective plasmid.

The next criterion for classifying plasmids is their incompatibility, i.e., inability to exist stably in one cell. Isogenic plasmids are incompatible, first of all. Thus, the F'lac plasmid cannot remain stable in an Hfr strain or in cells that already have one F factor. Incompatibility has also been demonstrated between such nonisogenic plasmids as, for example, ColV2 and F, ColV3 and F, C-1B2 and R222, etc. (Clowes, 1972). It is believed that the incompatibility of plasmids is indicative of their close relationship, as a result of the same phylogenetic origin. It has been demonstrated that incompatible plasmids usually have a considerably higher percentage of homologous polynucleotide sequences of DNA than compatible ones (Guerry, Falkow, 1971; Grindley et al., 1973). One of the most attractive and simple explanations of incompatibility is competition among related plasmids for the limited number of sites of attachment to the cell membrane. However, there are data indicative of a more complex nature of incompatibility (Clowes, 1972).

## Molecular Nature of Bacterial Plasmids

All of the known bacterial plasmids consist of circular, covalently closed double-stranded DNA molecules. The development of techniques for isolation and separation of plasmid DNA (see Helinski, Clewell, 1971; Clowes, 1972), as well as refinement of electron microscopic technology, have made it possible to determine the molecular weight of various extrachromosomal elements of bacteria (Table). After isolation from cells, plasmid DNA are demonstrable in the form of supertwisted, closed and open, circular (containing at least one break in one of the chains) molecules, or in the form of a complex with a specific protein (so-called relaxation complex--see below).

Number of replicas of plasmid DNA per cell: The Table lists the mean number of replicas per chromosome of a bacterial cell at the exponential stage of growth. All plasmids can be divided into two major groups, according to molecular weight and number of replicas: 1) large, usually transmissible, plasmids with a molecular weight of $30\text{-}100 \cdot 10^6$, which are usually present in the cell in a small number, one or two per chromosome; 2) small, nontransmissible plasmids with a molecular weight of $1\text{-}10 \cdot 10^6$, the number of which constitutes 10-15 or more per chromosome. Evidently, more rigid regulation of the few cycles of replication in the cell cycle is required for the large plasmids; in this sense, replication of large plasmids is under rigid control. Small plasmids, which replicate many times in the course of the cell cycle, in all probability have a looser system of regulation and are under less control.

It has been shown that the plasmid DNA content of a cell may depend on the bacterial strain. Thus, there are 1-2 replicas of the NR1 plasmid in cells of its natural host, E. coli; when it is transferred to Proteus mirabilis, the number of replicas increases to 10-12 per chromosome (Rownd, 1969). The lower control of replication is, perhaps, attributable to the lack of necessary genes in P. mirabilis cells, and it suggests that strict replication of plasmid DNA is achieved by means of repressors (Clowes, 1972).

The plasmid DNA content of a bacterial cell can change with change in growth conditions. With increase in generation time of E. coli cells at the logarithmic stage of growth and change in composition of the medium, the Rts1 factor DNA and colicinogenic factor E1 content per cell decreases proportionately to the decrease in chromosomal DNA content; as a result, the number of replicas of plasmid DNA per chromosome remains constant (Terawaki, Rownd, 1972; Vorob'yeva et al., 1974). Different data have been obtained for R1: in this case, the number of R1 DNA replicas per cell and per chromosome increased with increase in generation time (Engberg, Nordstrom, 1973). When the bacteria advance to the stationary phase of growth, the amount of plasmid DNA in cells can change, and it changes differently with different plasmids (Kontomichalou et al., 1970; Terawaki, Rownd, 1972): it may increase (R6K), remain constant (R28K) or decrease (Rts1). These data are indicative of differences in mechanisms of regulating replication of different plasmids.

Molecular weight of some plasmids and amount thereof in bacterial cells

| Plasmid | Molecular wt., millions of daltons | Number of replicas | Source |
|---|---|---|---|
| F | 35-75 | 1 | Freifelder, Freifelder, 1968; Bazaral, Helinski, 1970; Kline, Helinski, 1971 |
| F'lac | 55-72 | 1 | Freifelder, Freifelder, 1968; Clowes, 1972 |
| ColIb-P9 | 61-68 | 1 | Clewell, Helinski, 1970; Clowes, 1972 |
| ColV2 | 94 | 1 | Clowes, 1970 |
| ColB2 | 70 | 1 | " |
| Hlyα | 32&41 | 1 | Goebel et al., 1974 |
| Hlyβ | 58 | 1 | Goebel, Schrempf, 1971 |
| Ent ST | 20-25 | | So et al., 1975 |
| Ent ST+LT | 55-61 | - | " |
| R6K | 26 | 13 | Kontomichalou et al., 1970 |
| R15 | 46 | 1-2 | Nisioka et al., 1970 |
| R64 | 76 | 1-2 | Vapnek et al., 1971 |
| 222/R4 | 70 | 1-2 | Nisioka et al., 1970 |
| Δ | 60 | 1 | Clowes, 1972 |
| Penicillinase plasmid from Staph. aureus | 21 | 1-2 | Sheehy, Novick, 1975 |
| ColE1 | 4.2 | 12 | Bazaral, Helinski, 1968; Clewell, Helinski, 1972 |
| ColE2, ColE3 | 5.0 | - | Bazaral, Helinski, 1968 |
| S | 6.0 | 14 | Clowes, 1972 |
| CloDF13 | 6.0 | 10 | Kool, Nijkamp, 1974 |
| Minicircular plasmid from E. coli 15 | 1.5 | 12-15 | Cozzarelli et al., 1968 |
| Minicircular plasmid from Micrococcus lysodeikticus | 0.88 | 1 | Lee, Davidson, 1968 |

Note: Molecular weight was determined from sedimentation constants in neutral saccharose gradient or by means of electron microscopy, according to contour length of molecules. Molecular weight and number of replicas of plasmids, with the exception of bacteria specially mentioned, are given for E. coli cells.

An increase in R factor DNA is observed in P. mirabilis cells when antibiotics or drugs, resistance to which is determined by these plasmids, are added to the medium. It is known that transmissible R factors can be formed by reversible association of two components, one of which is responsible for transfer of genetic material in conjugation (RTF), while the other carries the genetic determinants of resistance (r). In E. coli cells, these components are usually associated in one replicon. However, when such R

factors are transferred to P. mirabilis, they become dissociated and are isolated in a cesium chloride density gradient as two classes of circular molecules varying in molecular weight and GC [guanine, cytosine] composition; each of the components is, apparently, capable of autonomous replication (Falkow et al., 1969; Nisioka et al., 1969; Cohen, Miller, 1970; Watanabe, 1971; Punch, Kopecko, 1972). Thus, the NR1 factor (R222) consists of two types of DNA molecules: r, with a molecular weight of $12 \cdot 10^6$ and 58% GC, and RTF, with a molecular weight of $54 \cdot 10^6$ and 50% GC (Punch, Kopecko, 1972). Rownd et al. (Rownd et al., 1971; Rownd, Mickel, 1971) found that if a P. mirabilis culture with NR1 is incubated for a long time on a medium with antibiotics, there is predominant synthesis and accumulation of the resistance component in the cells; its level reaches 30% of the chromosomal DNA content of the cell. This is associated with an increase in cell resistance to the antibiotic involved, due to an increase in dosage of resistance genes localized on the r determinant.

The phenomenon of amplification of the r component in the presence of an antibiotic, which was named transition, has also been demonstrated in other R factors (Rownd et al., 1973; Morris, Rownd, 1974; Clewell et al., 1975). With transition, the cells present large, polygenic molecules of R factors, which contain repeated sequences of r components (Morris, Rownd, 1974).

Complexes of plasmid DNA and protein: Refinement of methods of isolating circular DNA of plasmids, and in particular the use of mild, nonionic detergents to break cells down, such as Bridge 58 and sodium desoxycholate, made it possible to demonstrate that most of this DNA is present in the cell in a complex with protein. These complexes were first detected in the laboratory of Helinski, while working with colicinogenic factor E1 (see Clewell, Helinski, 1969, 1970; Blair et al., 1971). It was shown that, with the use of a soft [mild] method of isolation, 70-85% of the ColE1 DNA is sedimented 5% faster than the free supertwisted DNA, and it has a sedimentation constant of 24S, rather than 23S, as is the case for the supertwisted molecules. Treatment of the 24S fraction with any agent leading to deproteinization (for example, proteolytic enzymes, ionic detergents, alkali, phenol or heat) induced transformation thereof into open circular forms with a sedimentation constant of 17S. Such DNA-protein complexes were named Helinski relaxation (weakening) complexes, since removal of protein caused DNA to change from the supertwisted form to the open form.

Further analysis of the relaxation complexes revealed the following: 1) one molecule of ColE1 DNA is bound with ~240,000 dalton protein (Clewell, Helinski, 1970a); the molecular weight of the three main protein components is 60,000, 16,000 and 11,000 (Lovett et al., 1974); 2) the protein is connected only to the heavy strand of the ColE1 DNA molecule, and as a result of relaxation one break is formed (Clewell, Helinski, 1969, 1970a) in a very specific place in the DNA molecule (in relation to the site of the break of EcoR1 restrictase); there is reason to believe that the break occurs at the site of the start of replication of ColE1 DNA (Lovett et al., 1974); 3) synthesis of relaxation protein is depressed if glucose is present in the medium; a system of catabolite repression is involved in regulating synthesis of these proteins (Clewell, Helinski, 1972; Katz et al., 1973).

Analogous DNA-protein complexes have been found in a number of other bacterial plasmids as well: colicinogenic factors E2, E3, Ib-P9 (Clewell, Helinski, 1970b), F factor (Kline, Helinski, 1971), several R factors (Humphreys et al., 1972; Morris et al., 1973; Kupersztoch-Portnoy et al., 1974) and miniplasmids from E. coli 15 (Messing et al., 1972a). These complexes differ in several properties. Relaxation complexes have not been demonstrated in several hybrid plasmids (Hershfield et al., 1976).

In spite of the intensive study of the nature and structure of relaxation complexes, their physiological role in the cell has not yet been determined. It is quite likely that the protein of the complex is represented by a specific endonuclease; nuclease activity has been demonstrated only in protein from the complex of E. coli 15 miniplasmid thus far (Messing et al., 1973). In the works of Helinski et al. (see Clewell, Helinski, 1970a; Lovett et al., 1974), the hypothesis was expounded that the relaxation complex is a form of plasmid DNA potentially ready for replication. Perhaps, a break, formed either by the relaxation protein itself or the corresponding enzymes when it is removed, is necessary to initiate or terminate replication. However, it is now known that replication of DNA of small plasmids can take place for a long time under conditions of depression of relaxation protein synthesis by chloramphenicol (Clewell, 1972; Messing et al., 1972a) or glucose. These data indicate that functioning of relaxation protein is not mandatory for active replication. Experiments involved pulsed incorporation of labeled thymidine in ColE1 DNA revealed that the DNA-protein complex is not primary in the replication process, and that it is formed from supertwisted DNA molecules and specific protein (Katz et al., 1973; Sherratt, Helinski, 1973; Bogdanova, Gavrilov, 1974). Thus, the aggregate of available data indicates that DNA-protein complexes are most likely a form of existence of plasmid DNA molecules that are not undergoing replication at that time.

Multiple forms of plasmid DNA: As a rule, only monomeric forms of plasmic DNA are present in normally growing E. coli cells. However, in a number of cases, for example when plasmids are transferred to another bacterial strain or in the presence of diverse disturbances of normal cell metabolism, formation of multiple oligomeric forms is observed (Goebel, Helinski, 1968; Goebel, Kreft, 1969, 1974; Goebel, 1971; Inselburg, Fuke, 1971; Fuke, Inselburg, 1972; Goebel, Schrempf, 1972a). Such forms have been described primarily for plasmids present in a large number of replicas in the cell. A distinction is made between two types of oligomers: cyclic, in which two or more genomes are successively linked to one another, and catenoid, in which separate cyclic supertwisted and open molecules are linked. It is assumed that such forms can appear as a result of recombination (Hudson, Vinograd, 1967) or replication errors (Goebel, Helinski, 1968). It was shown that, in mutants of a host cell with recombination defects, there is formation of multiple forms of plasmid DNA to the same extent as in rec$^+$ cells of such strains (Goebel, 1971; Inselburg, 1973; Goebel, Kreft, 1974), i.e., apparently the bacterial Rec system is not involved in this process. Hence, the multiple forms of plasmid DNA are formed either due to a plasmid recombination system or impaired replication.

## Replication of Bacterial Plasmid DNA

Plasmids that replicate in the cells of a host bacterium make use of cell resources (precursors of DNA synthesis, energy sources, etc.) and enzymatic system of the cell for replication. The question of the extent to which replication of plasmid DNA and regulation thereof in the cell is implemented by chromosomal genes, and to what extent this is done by plasmid genes, is being studied intensively. Several chromosomal mutations have been found that affect synthesis of plasmid DNA. This includes, first of all, mutations that affect replication of chromosomal DNA (see below). The functions of plasmid genes in replication have been investigated less, and one of the reasons is that genetics of plasmids and mapping of plasmid genes have not been developed. However, we already know of mutations of plasmid genes that elicit a significant increase in number of plasmid replicas in cells (Morris et al., 1974; Kool, Nijkamp, 1974) and depression of replication of plasmid DNA at high temperatures (Terawaki et al., 1967). Various plasmid mutations affecting replication of ColE1 DNA, some of which were compensated by other plasmids (Kingsbury, Helinski, 1973a; Kingsbury et al., 1973), were obtained by the method of selective mutagenesis of the genes of small plasmids. It is imperative to study the mutations already known and to further develop genetics of plasmids in order to comprehend the mechanisms of replication of plasmid DNA and the correlation between plasmid and cellular syntheses.

Link between plasmid DNA and the cell membrane: According to the replicon hypothesis, expounded in 1963 by Jacob, Brenner and Cuzin (1963), the cytoplasmic membrane plays a substantial role in DNA replication and segregation. The replicating chromosome or plasmid is attached to specific parts of the membrane, which double as the cell grows; as a result, a copy of the specific replicative segment with a copy of the replicon attached to it is found in the daughter cell after cell division. The site of attachment of DNA on the membrane perhaps also controls initiation of replication.

At the present time, it has been reliably demonstrated that there is a link between the membrane and replicating bacterial chromosome (Smith, Hanawalt, 1967; Schachtele et al., 1970; Ivarie, Pene, 1973) and the DNA of some phages (Salivar, Sinsheimer, 1969; Altman, Lerman, 1970; Miller, Kozinski, 1970). A connection with the membrane has also been demonstrated for some plasmids. Cuzin and Jacob (1967), who studied replication of the autonomous sex factor F in E. coli cells, arrived at the conclusion that this plasmid is consistently linked with the structural component of the cell membrane. Direction demonstration of DNA-membrane complexes became possible after development of the technique of soft lysis of cells using the detergents, sarcosyl or Bridge, followed by separation of lysates in a saccharose gradient (Smith, Hanawalt, 1967). Using these methods, DNA-membrane complexes were demonstrated in a number of plasmids: ColE1 (Drygin et al., 1971); F, R, Coltrp (Shull et al., 1971); F'lac, ColI, ColE2 (Dowman, Meynell, 1973).

It was shown that plasmids differ in degree of attachment with the membrane. Up to 75-90% of the DNA of such large plasmids as F, F'lac, R and ColIbtrp is isolated from E. coli cells in the form of DNA-membrane complexes (Shull

et al., 1971; Dowman, Meynell, 1973). Evidently, large plasmids, the number of which does not exceed 1-2 copies per cell, are constantly bound with the bacterial membrane, like the DNA of the bacterial chromosome. In plasmids present in the cell in large number (10-20 copies per cell), the findings are quite different. Only a few (up to 30%) of the DNA replicas of these plasmids are bound with the membrane, while the rest are demonstrable in the form of free circular molecules (Drygin et al., 1971; Levy, 1971; Sheratt, Helinski, 1973; Dowman, Meynell, 1973).

Investigation of the process of replication of plasmids present in cells in a large number of copies, i.e., ColE1 (Bazaral, Helinski, 1970), NR1 in P. mirabilis (Kasamatsu, Rownd, 1970), miniring DNA from E. coli 15 (Goebel, Schrempf, 1972b), revealed that there is random choice of DNA copies for replication: 50% are replicated once, 25% twice and 25% not even once in the course of generation. Evidently, most of the copies are in the cytoplasm, and only the molecules undergoing replicating at the time are bound with the membrane. Indeed, Sheratt and Helinski (1973) demonstrated that the membrane fraction is markedly enriched with newly synthesized copies of ColE1 DNA with pulsed incorporation of labeled thymidine.

Initiation of plasmid DNA replication; the role of protein in initiating replication: It is known that de novo protein synthesis is required to initiate each cycle of replication of chromosomal DNA (Maaloe, 1963; Lark et al., 1963; Lark, 1969). Lark and Renger (1969) demonstrated that at least two types of proteins, varying in sensitivity to chloramphenicol, are involved in initiation. These proteins are formed successively at specific periods of the cell cycle before each act of initiation of replication of a bacterial chromosome. If protein synthesis is depressed, for example in the case of amino acid deficiency or under the influence of chloramphenicol, started replication cycles are completed, but new ones are not initiated.

At the present time, rather active research is in progress on the role of protein synthesis in initiation of plasmid DNA replication. It was shown that in the case of amino acid deficiency [starvation] or under the influence of chloramphenicol, replication of small ColE1 plasmids (Bazaral, Helinski, 1970; Clewell, 1972), miniring plasmids (Messing et al., 1972a), cloacinogenic factor CloDF13 (Veltkamp et al., 1974) and the small RSF1030 R factor (molecular weight $5.5 \cdot 10^6$--Crosa et al., 1975) continues for a long time in the absence of synthesis of chromosomal DNA. Many copies of plasmid DNA (up to 3000 copies of ColE1 DNA per cell) accumulate in the cells. Under these conditions, the rate of replication of plasmid DNA may be appreciably higher than normally. These data indicate that de novo synthesis of initiator proteins is not required to initiate replication of DNA of the small plasmids studied.

Only a limited number of acts of initiation in the absence of protein synthesis is possible for large bacterial plasmids: sex factor F (Bazaral, Helinski, 1970; Kline, 1974), R factors Rtsl and R222 (RTF) in P. mirabilis cells (Punch, Kopecko, 1972; Terawaki et al., 1974).

Effect of chromosomal mutations on initiation of replication: Investigation of heat-sensitive mutants deficient in initiation of replication of chromosomal DNA offer new approaches to comprehension of the mechanism of initiation of replication of plasmid DNA. At the present time, two groups of such mutants of E. coli, dnaA and dnaC, have been described and mapped. There is no initiation of new cycles of replication of chromosomal DNA when these mutants are transferred to intolerable temperatures (43°) (Wechsler, Gross, 1971).

According to the data of Goebel (1970, 1973, 1974a), synthesis of ColE1 DNA stops immediately at an intolerable temperature in the mutant for the dnaA locus, i.e., the product of gene dnaA is required to initiate replication of ColE1 DNA. Under these conditions, replication of large plasmids Hly and R1drd16 continues for some time, and this is indicative of the fact that these plasmids are capable of initiating several replication cycles. Synthesis of ColE1 DNA in dnaA mutants may be partially restored if one of the above-mentioned large plasmids is present in the cell, along with the colicinogenic factor. Evidently, these plasmids code synthesis of their own specific dnaA-like products, which may partially replace the chromosomal dnaA product required to initiate replication of ColE1 DNA.

The phenomenon of integrative suppression is indicative of a resemblance brtween the dnaA loci of large plasmids and chromosomes. It was shown that many F-like plasmids (F1, F'lac; ColV2, V3; ColB1, B2, B3, B4; ColVB; R1drd19, R192drd77, HlyPM152), incorporated in the chromosome, could compensate for the initiation defect in dnaA mutants by using plasmid initiator genes (Nishimura et al., 1971; Moody, Runge, 1972; Goebel, 1974b). In this case, replication of chromosomal DNA probably begins mainly at the site of plasmid integration (Bird et al., 1976). The phenomenon of integrative suppression was recently observed in I-like plasmids as well (Datta, Barth, 1976).

The conclusions of Goebel, that the product of gene dnaA is needed to initiate replication of ColE1 DNA are in contradiction to the data of Collins et al. (1975). It is difficult to determine which of the authors is right, particularly since different mutants for the dnaA locus are used in these works. With reference to another small plasmid, CloDF13, it was demonstrated that its replication depends very little on the product of chromosomal gene dnaA (Veltkamp, Nijkamp, 1974).

At 43°, chloramphenicol stimulates synthesis of ColE1 DNA and CloDF13 in dnaA mutant cells (Goebel, 1973, 1974a; Veltkamp, Nijkamp, 1974). These data are probably indicative of negative control of replication by the small plasmids studied. Goebel asssumed that the product of gene dnaA acts like an antirepressor, removing repressor from the site of initiation of replication.

The product of the dnaC locus is required for normal replication of all plasmids studied, large and small, but to different extents (Hly, R1drd16, ColE1, CloDF13--Goebel, 1970, 1973; Veltkamp, Nijkamp, 1974; Collins et al.,

1975). Synthesis of small plasmid DNA at intolerable temperature is less depressed; apparently, under such conditions, a certain number of initiation acts is possible for replication of their DNA.

The role of RNA synthesis in initiating replication: It is now a known fact that RNA synthesis is required to initiate replication of chromosomal and phage DNA (see Brutlag et al., 1971; Lark, 1972). It was shown that for initiation a ribonucleotide fragment must be synthesized, which has a free 3'-OH end, to which the deoxyribonucleotide that initiates the new DNA chain is covalently linked.

All of the plasmids studied also required RNA synthesis for replication. Rifampicin, which depresses RNA synthesis, suppressed replication of F factor (Bazzicolupo, Tocchini-Valentini, 1972), ColE1 (Clewell, Evenchik, 1973), R222 (Krcmery, Yanouskova, 1971), CloDF13 (Veltkamp et al., 1974), miniplasmids from E. coli 15 (Messing et al., 1972b) and penicillinase plasmid (Johnston, Richmond, 1970). Under normal growth conditions, the ribonucleotide sequences are dissociated from plasmid DNA in the course or at the end of their replication. However, this process is disrupted in the presence of chloramphenicol (Blair et al., 1972; Veltkamp et al., 1974) and fragments of RNA are demonstrable in synthesized plasmid DNA, in one of the strands of the circular molecule. It was shown that, in ColE1 DNA, such fragments consisted of 25-26 nucleotides with the following base composition: 10-11 G [guanine], 3 A [adenine], 5-6 C [cytosine] and 6-7 U [uridine]. The RNA fragments contain GMP [guanosine monophosphate] at the 5' end (Williams et al., 1973). Perhaps DNA polymerase I is involved in dissociation of the RNA fragment during synthesis of ColE1 DNA (Goebel, Schrempf, 1973).

Enzymes involved in plasmid replication: To date, we know of at least four different DNA polymerases that are involved in DNA replication (Moses et al., 1972; Wickner et al., 1973). Three of them have been studied rather well, and mutants have been isolated with impaired activity of these enzymes. Evidently, the cell polymerases replicate bacterial plasmids. At any rate, no polymerases have yet been found that are coded by the plasmids proper. There are only very indirect indications that plasmid R-Utrecht perhaps codes DNA polymerase I (MacPhee, 1974).

Various DNA polymerases of the bacterial cell are used in replication of different plasmids. It was demonstrated that DNA polymerase I is required for replication of small plasmid DNA: ColE1 and E2 (Kingsbury, Helinski, 1970; 1973b; Goebel, Schrempf, 1973), CloDF13 (Veltkamp, Nijkamp, 1973), mini-DNA from E. coli 15 (Goebel, Schrempf, 1972b). The DNA of small plasmids does not replicate in mutants of this polymerase (polA) and they are eliminated from the bacterial cells. At the same time, DNA of large plasmids ColV, ColIb, F'14, R64 (Kingsbury, Helinski, 1971) replicates rather actively in mutants with impaired DNA polymerase I activity.

According to the few data available at this time, DNA polymerase II is not important to replication of large and small plasmids (Hirota et al., 197]; Veltkamp, Nijkamp, 1973).

In ts mutants for DNA Polymerase III (dnaE), replication of small plasmids ColE1, ColE2, mini-DNA, CloDF13 continues for a long time at 42° (Goebel, 1972; Veltkamp, Nijkamp, 1973). Under these conditions, replication of large plasmids ColV, Vol1B, Hly and F stops at the same time as replication of chromosomal DNA (Goebel, 1972; Thompson, Broda, 1973), i.e., DNA polymerase III is required for replication of large plasmids, and function thereof is not essential to small ones.

Differences are also demonstrable in replication of plasmids in another group of mutants, which are heat sensitive for DNA synthesis--dnaB (this mutation affects elongation of DNA--Wechsler, Gross, 1971). At 43°, synthesis of ColV and Hly DNA stopped immediately in dnaB mutants, but replication of DNA of ColE1, CloDF13 and miniring plasmid from E. coli 15 continued (Goebel, 1970; Goebel, Schrempf, 1972a; Veltkamp, Nijkamp, 1974). The effects of other ts mutations for DNA elongation--dnaF and dnaG--have been investigated only in small plasmids ColE1 and CloDF13; the products of these chromosomal genes are required for their replication (Collins et al., 1975; Veltkamp, Nijkamp, 1974).

Thus, the submitted data indicate that various components of the replicative complex of the bacterial cell are involved in replication of large and small plasmids. It should be noted that replication of both large and small plasmids takes place in a semiconservative manner, in spite of the difference in enzymatic systems of synthesis thereof (Bazaral, Helinski, 1970; Goebel, Schrempf, 1972a; Kline, 1974).

Replicative forms of plasmid DNA. In vitro replication: Electron microscopy of pulse labled molecules of plasmid DNA isolated from minicells* (ColE1 and miniplasmid from E. coli 15) revealed the presence of replicative forms mainly in the Θ-configuration, which is consistent with the classical replication model of Cairns (1963). In these molecules, the size of the replicative loop ranged from 3 to 95% of the length of the entire molecule (Inselburg, Fuke, 1971; Fuke, Inselburg, 1972; Inselburg, 1974). Moreover, a very small amount of molecules with double-stranded linear tails were found, corresponding to the "rolling ring" model (Gilbert, Dressler, 1968). At present, it is difficult to state whether both or only one of these forms are really replicative.

Some new data on replication of ColE1 DNA were obtained in vitro (Sakakibara, Tomizawa, 1974a, b). It was shown that there is synthesis of complete molecules of ColE1 DNA in extracts of E. coli cells with DNA of colicinogenic factor E1, in the presence of four deoxyribonucleotides, four ribonucleotides, magnesium ions and NAD [nicotinamide adenine dinucleotide]. Isolation and separation of labeled ColE1 DNA formed in vitro revealed completely replicated, circular, supertwisted molecules and replicative forms containing a mean of two linear DNA fragments with a sedimentation coefficient in a

*Minicell refers to anomalous small cells formed upon division of E. coli P678-54 mutant. Minicells contain no chromosomal DNA.

saccharose concentration gradient of ~6S each. These fragments were not covalently linked with parent DNA chains. Addition of spermidine and glycerin increased sharply accumulation of intermediates, inhibiting their further replication. Thus, the authors observed intermittent synthesis of plasmid DNA of the Okasaki type. Synthesis of ColE1 DNA was sensitive to rifampicin, which is indicative of the need for RNA synthesis to initiate replication of ColE1 DNA in vitro.

Complete synthesis of plasmid DNA can also take place in extracts of non-colicinogenic cells on added ColE1 DNA. It was shown that chloramphenicol does not depress replication of ColE1 DNA in vitro. These data lead us to conclude that the products of plasmid genes are apparently unimportant to in vitro replication of ColE1 DNA (Tomizawa et al., 1975).

Recently, an in vitro system was described (Staudenbauer, 1976), that is more stable than the one in the work of Sakakibara and Tomizawa, and its capacity for synthesis of ColE1 DNA was higher by a factor of 10. In this system, there was semiconservative synthesis of complete molecules of ColE1 and CloDF13 DNA, and it depended on the presence of DNA Polymerase I in the cell extracts.

A study of replicative forms of ColE1 DNA, synthesized in vivo and in vitro, also revealed the following: 1) the starting point of replication of ColE1 DNA is in a specific part of the molecule at a distance of ~20% of the length of the molecule from the site of the break by restrictase EcoR1 (Inselburg, 1974; Tomizawa et al., 1974). There, too, is the replication termination point (Sakakibara, Tomizawa, 1974c); 2) replication of ColE1 DNA takes place in one direction*(Tomizawa et al., 1974; Inselburg, 1974); 3) replication proceeds on supertwisted molecules of ColE1 DNA without a break in one of the maternal chains (Sakakibara, Tomizawa, 1974a, b; Oka, Inselburg, 1975).

The supertwisted replicative forms, which contain noncovalently linked growing chains of daughter molecules in the region of the replicative "fork," were also demonstrated in replication of SV40 virus (Jaenish et al., 1971; Sebring et al., 1971) and mitochondrial DNA (Robberson et al., 1972). Thus, at least in some small plasmids and viruses, replication is possible without a break in one of the maternal chains of double-helical DNA molecules. However, the supertwisted state of replicative intermediates is apparently not a rule for replication of all plasmids. Thus, open forms of replicative intermediates were found in the larger penicillinase plasmid of Staph. aureus (Sheehy, Novick, 1975).

Apparently, a break in one of the maternal strands of the DNA molecule is needed for segregation of daughter molecules of plasmid DNA. In ColE1 DNA and miniplasmids from E. coli 15, it was shown that formation of open molecules at the termination stage precedes appearance of completely synthesized

*Recently, data were obtained on bidirectional replication of another bacterial plasmid R6K and formation from it of plasmid RSF1040 as a result of deletion (Lovett et al., 1975; Crosa et al., 1976.

supertwisted molecules (Sakakibara, Tomizawa, 1974c; Messing et al., 1974). In several plasmids of E. coli and Staph. aureus (R6K, penicillinase plasmids; the plasmid bearing tetracycline resistance), the replicative intermediates (precursors of supertwisted molecules) were catenoid dimers consisting of one superhelical and one open molecule (Novick et al., 1973; Kupersztoch, Helinski, 1973; Sheehy, Novick, 1975).

Replication of plasmid DNA in the cycle of cell division: The stable maintenance of plasmids in bacterial cells is indicative of the existence of mechanisms that control their replication in the cycle of cell division and segregation in daughter cells. There must be particularly rigid control of replication and segregation of the plasmids present in the cell in 1-2 copies. The amount of plasmid DNA must double in the course of the cell cycle and, after division, it must be evenly distributed in daughter cells.

A study was made of the system of control of replication of large plasmids with few copies in the cell with regard to the F'lac factor. Evaluation of replication of this plasmid was made indirectly, according to induced synthesis of β-galactosidase, which is coded by F'lac. It was demonstrated that replication of F'lac DNA occurs at a specific moment of the cell cycle of E. coli (Zeuthen, Pato, 1971; Cooper, 1972; Davis, Helmstetter, 1973; Collins, Pritchard, 1973). There is no agreement as to the exact event in the cell cycle that is coordinated with replication of F'lac DNA. No direct link was demonstrated between initiation of replication of plasmid and chromosomal DNA. The age of the cell in the division cycle, at which replication of F'lac DNA occurs, varies with different rates of bacterial growth. The hypothesis was expounded that initiation of replication of F'lac DNA may be coordinated with a specific cell mass (Davis, Helmstetter, 1973) and termination of replication of chromosomal DNA (Collins, Pritchard, 1973).

Less comprehensive studies were also made of another large plasmid, the colicinogenic factor ColBMtrplac$^+$ in the cell cycle of E. coli. The amount of copies of this plasmid in the cell was not exactly determined, but it is greater than the number of F'lac copies. It was demonstrated that replication of ColBMtrplac$^+$ is not synchronized with a certain phase of the cell cycle, and that it takes place throughout the division cycle; there is exponential increase in amount of plasmid DNA in the cell (Zeuthen et al., 1972; Tsoyten, Morozov, 1973).

As we have already indicated, there is random choice of copies for replication in the case of replication of small plasmids present in a large number of copies in the cells. Hence, it is obvious that all copies cannot replicate in the cell cycle simultaneously.

With regard to small plasmids, there are data only about the nature of synthesis of ColE1 DNA in the cell cycle of E. coli (Vorob'yeva et al., 1973). It was shown that replication of ColE1 DNA occurs continuously during the cycle of synchronous division of bacteria, with alternate periods of moderate rate of synthesis and doubling thereof. The nature of replication of ColE1 DNA in the cell cycle warrants the assumption that the limited number of replicative sites on the membrane is the factor that limits the rate of synthesis of plasmid DNA.

Thus, the submitted data are indicative of a different nature of replication of DNA of different plasmids in the cycle of cell division of the host bacterium and, consequently, different mechanisms of regulating replication of these plasmids in the cell.

Replication of plasmid DNA with conjugation: Our discussion of the distinctions of replication of bacterial plasmids would be incomplete if we did not dwell, at least briefly, on the special instance of plasmid replication with conjugation. Information on this score is available only with regard to some transmissible plasmids. It was shown that only one of the strands of plasmid DNA is transferred to recipient cells (in all of the cases studied this was the heavy DNA strand). The transferred linear DNA strand is immediately attached to the recipient membrane, where its complementary strand is synthesized. Then these molecules undergo cyclization; further, they can separate from the membrane (some of the R factors) or remain bound with it (F factors). Synthesis of the complementary strand and formation of double-stranded DNA molecules also occur in donor cells (Ohki, Tomizawa, 1968; Vapnek, Rupp, 1970, 1971; Falkow et al., 1971).

The mechanism of conjugational synthesis of plasmid DNA (transformation of single-stranded transferred DNA into double-stranded) differs from the mechanism of ordinary replication of double-stranded DNA molecules of plasmids. Conjugational synthesis takes place in the presence of chloramphenicol and rifampicin, as well as at intolerable temperatures in cells of mutants for elongation dnaB and dnaG (Vapnek, Rupp, 1971; Bresler et al., 1973; Wilkins, Hollom, 1974; Hiraga, Saitoh, 1975). Vapnek and Rupp (1971) assumed that the transformation of single-stranded DNA into double-stranded with conjugation is similar to repair synthesis, in which polymerase I is involved. However, it was demonstrated that the function of polymerase I is unimportant to conjugational synthesis of DNA; for this synthesis, like for normal replication of DNA of large plasmids, DNA polymerase III (Wilkins, Hollom, 1974) is required.

Conclusion

The data submitted in this survey are indicative of serious advances in the study of the structure and replication of bacterial plasmids. As we have shown, plasmids can be divided into two main groups, according to their size and nature of replication: large (mainly transmissible) and small (non-transmissible). Let us summarize the most substantial differences in replication of these two groups of plasmids.

1. Large plasmids are usually present in the cell in a small number of copies, one or two per chromosome; there are considerably more copies of small plasmids, 10-15 per chromosome or more; there is random selection of small plasmid copies for replication.

2. Most of the DNA of large plasmids is consistently bound with the cell membrane; only a small amount of copies of small plasmids is bound with the membrane; evidently, these are replicating copies.

3. Only a limited number of acts of initiation of replication of large plasmids is possible if protein synthesis is depressed; protein synthesis is not required to initiate replication of DNA of small plasmids.

4. In the process of elongation of DNA replication in large plasmids, the product of the dnaB locus, which codes the host chromosome, plays a substantial role; synthesis of DNA of small plasmids can take place in the absence of this product.

5. DNA polymerase III is mandatory for replication of DNA of large plasmids, and normal function of DNA polymerase I is unessential; conversely, DNA polymerase I is required for small plasmids and polymerase III is unimportant. At the present time, it is not clear whether the difference in behavior of plasmids in strains with markedly diminished DNA polymerase activity is related to the basically different types of DNA synthesis in these plasmids.

It should, however, be noted that the separation of plasmids into two groups is somewhat arbitrary; there are also exceptions; for example, there are small plasmids present in 1-2 copies in the cell (Lee, Davidson, 1968) and large plasmids with many copies in the cell (Rownd, 1969). Of course, such appreciable differences in replication and control thereof could not be attributed solely to the differences in plasmid size. Thus, it was shown that the small plasmid pSC101 (mol. wt. $5.8 \cdot 10^6$), obtained from a large R factor, retains the features inherent in replication of this large plasmid (Timmis et al., 1974). Evidently, the replicative genes of these two groups of plasmids could also differ, and this could be the result of different evolutionary origin of plasmids. The data on hybridization of plasmid DNA confirm this assumption. Hybridization of the DNA of several small plasmids (three miniring plasmids with mol. wt. of 1.45, 1.8 and $2.3 \cdot 10^6$ and ColE1) revealed up to 40% homologous nucleotide sequences (Goebel, Schrempf, 1972c). Upon hybridization of DNA of several large plasmids (F, R6, R100, R1, ColV-K94, R222, R1drd, Ent3--Guerry, Falkow, 1971; Cohen et al., 1971), it was found that these plasmids have 40 to 70% nucleotide sequences in common, which are situated compactly in one half of the plasmid DNA molecule; evidently, the homologous loci contain genes that control manifestation of sex properties of transmissible plasmids, as well as a system of autonomous replication. With cross-hybridization of DNA of large and small plasmids, less than 1% common homologous sequences was demonstrated (Goebel, Schrempf, 1972c), i.e., there was actually not a single gene in common in the DNA molecules of these groups of plasmids.

Interestingly enough, two different types of replicative systems may function on one plasmid. The hybrid plasmid obtained in the laboratory of Cohen from pSC101 and ColE1 DNA replicated in the presence of chloramphenicol, like ColE1, and could be reproduced in the mutant for polymerase I (polA) like pSC101 (Timmis et al., 1974). Evidently, in nature the existence of recombinant plasmids is also possible, and they are capable of different types of replication. This trait may impart great breeding advantages to such plasmids.

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PUBLIC HEALTH

## HOSPITAL FOR BRONCHIAL ASTHMA ESTABLISHED IN SALT MINE

Moscow TRUD in Russian 14 Apr 77 p 3

/Article by I. Melenevskiy, settlement of Solotvino, Zakarpatskaya Oblast: "An Underground Hospital"/

/Text/ Most of those treated for bronchial asthma at the Solotvino Allergological Hospital depart healthy. This hospital is located deep underground.

A spacious cage carries us at a tremendous speed deep down, to impenetrable darkness--100, 200 meters. Our temples are throbbing. Our ears are stuffed. There is a smooth stop at the 300-meter mark.

At one time people mined salt in Solotvino. Now, in accordance with the decision of Ukrainian authorities, a republic allergological hospital has been established at the place of the old workings.

Daylight lamps shine brightly. The tall arches of the wide corridor recede far into the distance. Two buses can freely pass each other in it. The salt wall "facing" sparkles and fancifully iridesces in the lamp light.

The main gallery is a unique service building. It contains physicians' offices, rooms for medical personnel, a room where patients change their clothes, a gymnasium for corrective physical culture and a red corner.

Together with P. Gorbenko, chief physician of the hospital, we go on a short excursion. Other galleries--Tektonicheskaya /Tectonic/, Stalaktitovaya /Stalactitic/, Gippokrata /Hippocrates'/ and Speleologov /Speleologists'/--are located to the right and left of the main gallery--Khrustal'naya /Crystalline/. Patients invented these names. There are niches in the walls behind attractive curtains. These are hospital wards. Some are for two patients--up to 12 square meters--and others, for four patients--twice as big. They have comfortable wooden beds and small tables. The pillows on the beds are made of porolon, not of feathers, and the blankets are wadded, not woolen--all this from considerations of antiallergenicity.

Patients come to the ward in the evening and sleep there until morning. The course of treatment lasts 300 mine hours.

The following are some characteristics of the microclimate of the salt mine related to us by P. Gorbenko. Stable temperature is +23 degrees. Low air humidity is up to 40 percent. High saturation of the atmosphere with common salt is 10 mg per cubic meter. Absolute quiet reigns there, the environment is completely nonallergenic and the number of microorganisms in the air is negligible (five times lower than in the most sterile operating room). The hospital patients are protected from any radioactive and electromagnetic radiation.

Thousands of people who came here sick and desperate, having tried various methods of treatment, ended their sufferings.

Indeed, it is necessary to make things clear. Bronchial asthma is divided into three forms--light, medium and serious. The first two forms are successfully treated with the microclimate of salt mines, while the third form, not so successfully. Scientists and physicians work persistently to make the course of treatment at the local allergological hospital more effective.

Often results are observed as early as the second week. Patients stop coughing, their shortness of breath disappears and their seizures end. By the end of the fifth week, using the language of medicine, it is possible to attain a full remission--restoration of normal bronchial activity.

What is the mechanism of the curative effect of salt mines? We asked the physicians to answer this question.

M. Torokhtin, doctor of medical sciences, professor, director of the Uzhgorod Affiliate of the Odessa Scientific Research Institute of Health Resort Science:

"The course of speleotherapy is connected with breaking the patient's contact with the environment that constantly affected him at his place of residence, as well as with the effect of the special microclimate. The heavily saturated aerosol of common salt in the air is the chief thing. It affects the bronchopulmonary system and removes all admixtures from it. A considerable amount of sodium and calcium, which the organism lacked, enters the body through the cleared respiratory tracts. Thus, the work of the adrenal cortex is normalized considerably. Under the effect of the mine microclimate the immunological reactivity of the organism rises and its sensitivity to all the investigated allergies is reduced. The recovered person puts on a reliable protective armor guarding him from asthma forever, or in any event for a long time."

A. Koshel', physician at the allergological hospital:

"I have worked at the hospital for 7 years. Basically, I look after the health of 7- to 14-year old children. The effect is remarkable. At the end of the course of treatment the children forget about bronchial asthma forever. It is only a pity that difficulties hamper the treatment of juveniles--every now and then various organizations impose a ban on their descent to the mine."

Despite the support given to the Solotvino Hospital by local authorities of Zakarpatskaya Oblast there are many difficulties. In a number of cases the solution of problems depends on republic and even Union organizations.

First of all, the treatment of children. As we have already stated, the microclimate of the Solotvino Mine proves to be miraculous for small patients. However, in the last few months they have ceased to be treated there. The Ukrainian State Committee for Supervision of Industrial Safety and for Mining Inspection demanded that devices, which could reliably protect children from a possible exposure to carbon monoxide, be made for children's descent underground. The Solotvino Mine has been in existence for more than 150 years and no accidents connected with carbon monoxide occurred there during that time. However, rules are rules. Adults have such a device--a portable breathing apparatus. Children need improved devices. After a long search they were found--they turned out to be gas masks with garkolit elements. It would seem that the problem has been solved. Only the sanction of the republic's Ministry of Health for the use of gas masks is needed. However, for more than 6 months now the Ukrainian SSR Ministry of Health has been unable to solve this simple problem. The atmosphere in Solotvino is heated. Unhappy parents are "bombarding" local authorities with requests to admit sick children for treatment, but receive rejections in response. One would think that the USSR Ministry of Health should examine the reasons for this situation. Help must be given to do everything needed so that children may also continue to be treated at the Solotvino Hospital.

Many unsolved problems of the underground hospital are due to the fact that the method of speleotherapy is new. Without having experience and analogies, it is not easy to immediately arrive at such decisions. We have already discussed the beneficial effect of the local treatment. However, it may be that its duration should not always be the same for all patients--for adults and children and for patients with various stage of the disease. The physicians themselves say that the time of stay in the mine can differ. What can it be? In order to answer this, skilled investigations by scientists and scientifically substantiated methods are needed.

In Uzhgorod there is an affiliate of the Odessa Institute of Health Resort Science and a medical university faculty. They help physicians as much as possible. However, in the opinion of practical workers, serious scientific investigations by allergological scientists are needed. Perhaps specialists from the Moscow Scientific Research Allergological Laboratory of the USSR Academy of Medical Sciences and the Leningrad Institute of Pulmonology should be enlisted in this?

Hospital workers complain about a certain discrepancy in their pay. Why do all those who work at the salt mine, even the operators of the cage that lowers people underground, have wage increases and pension privileges? All this does not apply to the workers of the allergological hospital. Of course, the labor of salt miners cannot be compared, for example, to that of physicians. However, the workers of the medical center at the mine have such privileges. This means that, in principle, a solution of the problem is possible. Apparently, it is necessary to approach this matter more flexibly, otherwise the formed and efficiently working collective of medical allergologists can be lost.

And the last thing, which we must not fail to state. As yet the capabilities of the Solotvino Hospital are very limited. Eight years ago there was a hospital for patients from the Transcarpathian area alone here. It exist also now--an oblast hospital for 75 beds. Later, when physicians and scientists became convinced of the unique effect of speleotherapy, it was decided to establish a republic allergological hospital for 120 beds in Solotvino. Thus, there are now 120 plus 75. But there are hundreds of times that number who wish and really need to come here.

Several years ago, when an all-Union scientific and practical conference devoted to the effect of the microclimate of salt mines on the treatment of patients suffering from bronchial asthma was held in Solotvino, B. V. Petrovskiy, USSR minister of health, came here. He supported local physicians and gave a high rating to their work. "Equipping a hospital in the Solotvino Mine," he said, "should be considered a major preventive matter. Probably, we will make an ever greater use of such hospitals, such salt mines, in the country every year."

Time is passing and for the time being the Solotvino Hospital is the only one in the country. Yet we have many old salt mines, where such hospitals could be built. As we were told at the Institute of Pulmonology, this could be done in Permskaya Oblast, in the old salt mines of the Urals, in Kirgiziya and in a number of other regions in our country. Speleotherapy is a young, but a very promising method. This does not mean that specialists believe that it is a panacea. But it provides excellent help to many people. Once it helps, it means that it should be studied and developed.

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# MEDICOSOCIAL ASPECTS OF AGING OF THE POPULATION

Moscow SOVETSKOYE ZDRAVOOKHRANENIYE in Russian No 6, 1977 received 28 Feb 77 pp 8-13

/Article by D. F. Chebotarev, Institute of Gerontology of the USSR Academy of Medical Sciences, Kiev/

/Text/ In modern medical science there are relatively few problems which, like gerontology, have attracted such close, rapidly increasing attention not only on the part of theoreticians and practical workers in medicine, but of representatives of many other sciences, primarily sociologists and economists, in a relatively short time.

It is quite obvious that the traditions and relations connected with satisfaction of the needs of middle-aged and old people formed in the past are now being destroyed in many countries. This occurs not only as a result of the significant increase in the absolute and relative number of middle-aged people (individuals 60 years of age and older comprise 18 to 22 percent of the population in economically developed countries), but also under the effect of an intricate set of economic and social changes connected with technical innovations and urbanization.

Today no one will dispute the fact that the problems of old age and aging of the population and of assistance to middle-aged and old individuals are not only of a medical nature. They also have various social, cultural and economic aspects affecting the life of the society at large.

In his report at the 28th session of the UN General Assembly (1973) the UN Secretary General pointed out that "in most countries aging of the population has a profound effect on the structure and function of the family, on manpower and economcc policy, on the goals and organization of the system of public health and social services and on the policy and practice of governments."

Attention to the profound demographic shifts begun during the first decades of the 20th century and to their consequences should also be prolonged into the future. The forecasts based on an analysis of current tendencies indicate that in all the regions of the world from 1970 through 1980 the rate

of increase in the population group of 60 years of age and older will exceed the rate of increase in the total world population, as well as of any other age group.

More remote forecasts also confirm this. For example, according to UN statistical data the number of people 60 years of age and older throughout the world by the year 2000 will more than double as compared with 1970, increasing from 291 to 585 million. At the same time, the proportion of the people of this age in the total structure of the world population will increase from 8 to 9 percent.[1] In developed regions this indicator will reach 16 percent, on the average.

Aging of the population characterized by an increase in the absolute number of middle-aged citizens is closely connected with the achievements in the field of mortality control and with the increase in the average longevity of people. At the same time, the increase in the proportion of middle-aged people in the total population is due primarily to a decline in the birthrate.[2] The decline in the birthrate and advances in social development and medicine will bring about further aging of the population not only in developed, but also in developing countries, where the aging process, apparently, will proceed at accelerated rates. Thus, aging of the population becomes a worldwide phenomenon.

"It is paradoxical," the decision of the expert committee on aging of the World Health Organization states (1973), "but the technical achievements in medicine, which facilitated contraception and lowered the sick rate in the second half of life, put the needs of middle-aged individuals in a prominent place, because these achievements contributed to universal aging of the population."[3]

When the various aspects of the problem connected with aging of the population is examined, the factor of the quite great difference in the average longevity of men and women observed everywhere, but especially pronounced in many economically developed countries (in the Soviet Union the average longevity of forthcoming life is 65 years for men and 74 years for women), should also be taken into consideration. As a result, the middle-aged population of developed countries is made up mainly of women.

Statistical investigations of recent years indicate that a very alarming factor--cessation of the increase and even reduction in the average longevity of men--has appeared against the general background of a gradual increase in the average longevity of the population. For example, according to the data of Swedish statistics in 1972[4], in 14 European countries from 1958 through 1968 for 65-year old women the expected longevity increased by 0.7 years, on the average, and for men of the same age it decreased by 0.3 years.

The problem of loneliness, which occurs as a result of the death of relatives, divorce and separation from family and often entails a loss of interest in life and social isolation, turned out to be very important. In the USSR during the period between the 1959 and 1970 censuses the number of single people

of different ages increased from 9.4 million (4.5 percent of the total population) to 14.2 million (5.9 percent).[5] Such a rapid increase in the number of people living alone is largely connected with the advances in housing construction.

During the period between the two latest all-Union population censuses, that is, in only 11 years, among people 60 years of age and older the percent of single people increased from 13 to 19 (from 2,652,000 to 4,800,000). In the USSR Baltic Republics this percent is 1.5 to 2 times higher than the all-Union percent. Primarily middle-aged and elderly women are single. For example, according to the data of 1959, a total of 2.06 million single women and only 0.59 million men were recorded, and in 1970 among 4.8 million single people only 0.3 million were men.[6, 7]

The profound demographic shifts, which brought about the rapidly progressing process of aging of our country's population, essentially, were revealed only during the postwar period. During the period between the 1939 and 1970 population censuses, that is, in only 31 years, the relative number of people 60 years of age and older in our country almost doubled (from 6.7 to 11.8 percent of the total population, and in 1975, to 13.2 percent).[8] During the 11 years between the two latest censuses of 1959 and 1970 the number of middle-aged and elderly people increased by 26 percent.

The following statistical data characterize the change in the population's age structure. Whereas in 1939 there were 16.6 million individuals who reached the pension age, and in 1959 there were 25.5 million, in 1970 their number increased to 36.3 million. According to statistical forecasts, in the near future it will increase to 44 million, that is, individuals of pension age will comprise up to 16 percent of the total population. The Baltic Republics now pertain to regions with the most pronounced demographic shifts (16 to 17 percent of the population is above the age of 60). Rapid rates of development of this process were noted in the European part of the RSFSR and in the Ukrainian, Belorussian and Georgian SSR in the last decade.[9]

The data cited by V. P. Perevedentsev give an idea of the age change in the structure of our country's population (tables 1 and 2).

Whereas the indicators of table 1 give a clear idea of the decrease in the proportion of children and adolescents and the increase in the number of people over the age of 60 with retention of the groups of able-bodied age, the data of table 2 show how the process of aging takes place in the basic able-bodied population group.

Aging of the able-bodied population requires special attention in connection with the fact that, as the accumulated data indicate, labor productivity declines in middle age (45-59). New occupations arising under conditions of the scientific and technical revolution place greater demands on workers with which people of this age often do not cope.

Table 1. Age Structure of USSR Population (in %)

| Age, Years | 1939 | 1959 | 1970 |
|---|---|---|---|
| Up to 19 | 44.5 | 37.4 | 38.0 |
| 20-59 | 48.7 | 53.2 | 50.2 |
| 60 and older | 6.8 | 9.4 | 11.8 |

Table 2. Dynamics of Age Structure of USSR Population (in %)

| Age, Years | 1959 | 1970 | 2000 |
|---|---|---|---|
| 0-19 | 37.4 | 38.0 | 32.1 |
| 20-39 | 33.1 | 28.5 | 28.1 |
| 40-59 | 20.1 | 21.7 | 22.9 |
| 60 and older | 9.4 | 11.8 | 16.9 |

Demographic forecasts indicate that an increase in the able-bodied population in the country in the last 15 years of our century will amount to only 5 million people. It will be six times lower than during the preceding 15 years and three times lower than during this five-year plan (1976-1980). Thus, the increase in the able-bodied population exceptional in its magnitude will cease completely in the near future.[11]

Although the total number of dependents (individuals of nonable-bodied age) per 1,000 able-bodied individuals does not change much, the actual load on them in connection with aging of the population increases considerably. This is connected with the fact that the support of one person of pre-able-bodied age is 1.5 to 2 times cheaper than that of a middle-aged person who retires from occupational activity.[12]

The problem of correcting highly undesirable demographic shifts and their consequences should be solved through a purposeful effect on the regime of reproduction of the population and on the creation of the appropriate conditions stimulating the birthrate and facilitating children's education.[13] However, this is only one of the aspects of the social policy of our state. The situation that has been created also requires increased attention to and efficient measures with regard to another consequence of demographic shifts, which is the vast and constantly increasing group of people of pension age already forming almost one-sixth of the country's entire population. This attention is due to considerations of a sociopsychological and physiological, as well as economic, nature.

Modern sociologists rightly maintain that the significant aging of the population necessitates a rapid development of gerontology and sharply increases its national economic and social significance. In particular, the socio-hygienic and psychological problems raised include the most advisable employment of middle-aged people; development of possibilities and efficient limits

of utilization of so-called residual work fitness and methods of retraining, preparation for retirement on pension and improved pension security; study of the position of the middle-aged and old man in the family and society, which changes after the end of occupational activity and often is connected with isolation, lack of proper attention and support on the part of family members and so forth.

The Soviet Government, taking into consideration the interests of our country's rapidly developing economy, on the one hand, and the importance of activity for individuals of older ages in order to maintain their health and prestige in the family and society, on the other, issued a number of decrees envisaging material incentives for individuals of pension age for the purpose of involving them in socially useful labor. The indicators of employment of middle-aged people throughout the republics differ considerably, which attests both to territorial differences in the possibilities of utilization of the labor of individuals of pension age and to the uniqueness of a subjective attitude to the problem of discontinuing or continuing labor activity. For example, among men of early pension age (60 to 64) in cities minimal employment comprises 27.2 percent (Kazakh SSR) and maximal, 58 percent (Lithuanian SSR), while the average Union indicator is 32.3 percent.[14] With the appropriate attention of planning organizations and managers of production facilities this indicator can be greatly increased during the first 5-year period of pension age and to a certain extent extended to the next 5-year period.

The practical measures implemented in this direction should be closely coordinated with the available data on age physiology and occupational gerontology. It is difficult to overestimate the practical importance of the age physiology of labor. Failure to take its requirements into consideration leads to early occupational aging and does direct damage both to production and to workers.

The health of the middle-aged person who retires on a pension largely depends on his psychological adjustment and on the extent to which he will be able to cope with the fundamental break from the habitual stereotype and to find new activities and new interest in life. In the opinion of gerontologists, this is one of the basic risk factors causing the onset of premature aging and death. Unfortunately, neither organizers of medicosocial assistance, nor managers of production facilities and institutions attach significance to this.

The health of the middle-aged family member is also of definite importance for a reduction in the intensity of unfavorable demographic shifts and increase in the birthrate. When it is preserved, the middle-aged person very often becomes a helper in the education of the young generation. His presence in a family creates the possibility for occupational activity for both parents. Conversely, the premature aging of middle-aged people and their affection with diseases requiring outside care often make it necessary for one of the family members to stop his occupational activity.

Thus, a number of specific, medical, psychosocial and economic problems produced by relatively new characteristics of the age structure of our country's population and by the consequences of their emergence are also most closely interwoven here.

The existing forms of organization of practical public health emerged during past decades and, naturally, do not properly take into consideration the requirements now placed on it by the rapidly advancing aging of the country's population. Apparently, the staffs of boarding homes for old people were calculated with due regard for seemingly healthy old men alone. These homes have now been largely transformed into residences for chronic patients and senile old men, 60 to 80 percent of whom are confined to bed and need appropriate medical care and treatment.

Meanwhile, in the last 16 years (1959-1975) alone the number of people over the age of 60 increased by 10 million and the number of middle-aged and old people living alone increased by 2 million. All this has made the solution of the task of changing some forms of existing organization of medical aid to the population of older ages even more urgent. There is a need to increase in it the elements of social and domestic aid to a vast group of those that require it. The generalization of the results of in-depth studies already conducted in our country attests to the formation of qualitatively new needs of the population of older ages.

The medical and social aspects of the organization of services for middle-aged people are determined by a number of factors. One is the specific nature of age pathology, as a rule, chronic and multiple. On the average, the middle-aged man has four diagnoses. His pathology is compared with an iceberg, only one-seventh of its total mass being visible. Another is the sharply increased need for hospitalization for prolonged treatment and medical care when it is impossible to meet it under home conditions. According to the data of recent years, in hospitals for adults in socialist countries and countries of Western Europe patients 60 years of age and older comprise almost 50 percent of all those receiving hospital treatment. Still another is the increased demands on the district medical network connected with priority home visits (visits to people over 60 years of age comprise more than 40 percent of all the visits) and with the need for the organization of prophylactic medical examination of middle-aged people both workers and pensioners during a period of increased risk (retirement from occupational activity, death of a close person and the isolation that sets in, age over 70 and so forth). Still another factor is the need for new knowledge by the medical personnel in the field of gerontology and geriatrics concerning the physiology of middle-aged and old people, the nature of their pathology, the course and treatment of diseases, characteristics of rehabilitation and reactions to ordinary medications and methods of treatment and knowledge of the psychology of people of these age groups, methods of preventing premature aging and so forth. Finally, there is the need for the organization of not only medical aid, but also of social and domestic services (especially for people living alone), which should be carried out with the enlistment of workers of other departments (social security, the Red Cross and Red Crescent

societies, city and rayon executive committees of workers' deputies and so forth). It is very important right now to make preparations for the solution of these urgent tasks in order to ensure further improvement in medical aid to the country's population.

In his article "Therapeutic Aid Must Be Improved" academician B. V. Petrovskiy, USSR minister of health, writes the following: "The problem of gerontology and geriatrics acquires exceptional importance in our time. It is necessary to expand scientific investigations, to create firm contacts with social security institutions and to organize wards and hospitals for treating old-age patients."[15]

In connection with the experience in the organization of geriatric and medicosocial aid there already is quite extensive literature illuminating foreign experience, in particular, the experience of socialist countries and the tasks facing Soviet public health and social security. A number of studies originating from the Institute of Gerontology of the USSR Academy of Medical Sciences[16, 17, 18, 19], the All-Union Scientific Research Institute of Social Hygiene and Organization of Public Health imeni N. A. Semashko[20] and other scientific research institutions dealing with these problems have been published in the last few years.

The accumulated Soviet and world experience should form the basis for organizational measures for improvement in medicosocial aid to the population necessary in connection with its new demographic qualities and needs.

FOOTNOTES


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16. Revutskaya, Z. G., in the Collection "Osnovy Gerontologii," Moscow, 1969, pp 582-601.

17. SOV. ZDRAVOOKHR., 1964, No 8, pp 3-8.

18. Sov. ZDRAVOOKHR., 1972, No 7, pp 3-9.

19. Vinogradov, N. A., and Revutskaya, Z. G., in the Collection "Vedushchiye Problemy Sovetskoy Gerontologii" /Leading Problems of Soviet Gerontology/, Kiev, 1972, pp 263-276.

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## SCIENTIFIC COUNCIL OF BIOKHIMREAKTIV MEETS IN OLAYNE

Riga SOVETSKAYA LATVIYA in Russian 6 Apr 77 p 2

/Article by V. Yanov: "Horizons of Biokhimreaktiv"/

/Text/ During the past five-year plan the personnel of the Olayne Chemical Reagent Plant mastered the output of more than 100,000 types of organic reagents and biochemical preparations. The Biokhimreaktiv Scientific Production Association was established at the base of this enterprise, as well as of the former Latvian Affiliate of the All-Union Scientific Research Institute of Reagents transformed into the All-Union Scientific Research Institute of Applied Biochemistry, in Olayne not long ago. The Riga Reagent Plant also became part of it.

The association developed and mastered techniques of producing many valuable reagents and preparations used in scientific laboratories, in medical and food industries and in perfumery. They include destibiotin, which accelerates microbiological processes, pectavamorin, a technical enzyme used for the preparation of fruit juices and in the wine industry, and phenazon, a preparation for chemical weeding of sugar beet fields. The production of an effective drug known under the name of ATF is being mastered. It dilates heart vessels and improves the work of the heart muscle.

The personnel of the Biokhimreaktiv Association must do even more during the time remaining before the end of the five-year plan. For example, the All-Union Scientific Research Institute of Applied Biochemistry should fully play the leading role in the coordination of all the scientific research connected with the production of biochemical preparations. Measures ensuring the output of 1,200 types of biochemical reagents for scientific investigations, mainly in the field of molecular biology and genetics, during the last year of the five-year plan will be implemented.

These and other facts were cited at the first meeting of the association's scientific and technical council recently held in Olayne. Along with production workers, it also included chemical scientists from a number of the country's leading institutes--I. Berezin, corresponding member of the USSR

Academy of Sciences, D. Knorre, corresponding member of the USSR Academy of Sciences, Ye. Severin, doctor of chemical sciences, V. Perekalin, doctor of chemical sciences and others.

In particular, the participants in the meeting discussed the report by V. Zamakh, director general of the association, on the prospects for its development during the Tenth Five-Year Plan and subsequent years and adopted a decision aimed at a successful implementation of the tasks set by the 25th CPSU Congress for developers of organic reagents and biochemical preparations.

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